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# FINAL
# OPERATION AND MAINTENANCE PLAN
# SECOND OPERABLE UNIT
# SULLIVAN'S LEDGE SUPERFUND SITE
# NEW BEDFORD, MASSACHUSETTS

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## 1.0 INTRODUCTION

In accordance with Section VIII.C.1.d.iv(c). of the Scope of Work for Operable Unit 2 (SOW-OU2) (USEPA 1992a) of the Sullivan's Ledge Superfund Site in New Bedford, Massachusetts, the Consent Decree (CD) (USEPA 1992b) and the approved Remedial Design (RD) Work Plan (Dames & Moore 1995a), this final Operation and Maintenance (O&M) Plan has been prepared for AVX Corporation as part of the 100% Remedial Design. Section VIII.C.1.d.iv.(c) further requires that a "final Operation and Maintenance Plan consistent with Section VIII. C.1.d.iii(c)" be included in the 100% Remedial Design. Section VIII.C.1.d.iii (c) of the SOW-OU2 details the following requirements:

> *(c) a draft Operation and Maintenance Plan designed to ensure the long-term continued effectiveness and permanence of the remedial action that shall include*
>
> *i. the items in (a) through (d) below:*
>
> *(a) sediment/soils, wetlands, and air monitoring adequate to monitor the effectiveness of the Second Operable Unit Remedy;*
>
> *(b) compliance with other applicable state and federal requirements*
>
> *(c) requirements described in Section VI.A.5.,6. and 7.(wetland restoration assessment and wetland maintenance) of this SOW;*
>
> *(d) submittal of yearly reports in accordance with Section VII.G.3 (yearly review of institutional controls) of this SOW that describe*

*the results of the monitoring of implementation and effectiveness of the institutional controls specified in Section VII.F. of this SOW.*

This final O&M Plan is intended to address long-term reviews of the remedy performance after USEPA approval of the Final Remedial Construction Reports, and does not address the short-term maintenance requirements during construction (which will be addressed by the Environmental Monitoring Program in the Remedial Action Work Plan (RAWP)). Portions of this final O&M Plan are contingent upon the actions undertaken during the implementation of Operable Unit 1 (OU1). It should therefore be understood that this document will be amended or revised at the time of the Final Construction Inspection.

## 1.1 ENVIRONMENTAL MONITORING PROGRAM REQUIREMENTS

Section VIII.C.1.d.iii(c)i.(a) of the SOW-OU2 states that this O&M Plan should address environmental monitoring with respect to "*sediments/soils, wetlands, and air monitoring adequate to monitor the effectiveness of the Second Operable Unit Remedy.*" Detailed requirements for environmental monitoring are also presented as RA requirements in Section IX.B.1.d of the SOW-OU2. Table 1-1 presents a synopsis of the Section IX.B.1.d environmental monitoring program requirements, and how each requirement will be addressed either in the O&M Plan (post-construction, long term) or in the RA Work Plan (during construction, short term).

## 1.2 TRANSITION FROM CONSTRUCTION TO O&M

The succession from wetland construction through completion of Remedial Action and long-term O&M incorporates milestones defined in the SOW and CD. This plan is consistent with achieving these milestones through the following steps leading to completion of the OU2 remedy and initiation of long-term monitoring.

1. OU2 submits Closeout Reports for sediment excavation and disposal and wetland restoration including certification of completion of construction (SOW-OU2, IX.B.6).

2. Upon EPA approval, after reasonable opportunity for review and comment by MADEP, of the Certification of Completion of Construction, the O&M period begins. The O&M period includes Annual Post-Construction Monitoring and Long-Term Monitoring.

3. OU2 institutes O&M in accordance with the O&M Plan (SOW-OU2, X.)

4. OU2 submits annual O&M reports. The reports will include Post-Construction wetlands annual monitoring results for 5 years. The Annual Post-Construction Monitoring will continue beyond the 5 year period until the Demonstration of Compliance Report has been approved by EPA after reasonable opportunity for review and comment by DEP (SOW-OU2,VI.B).

5. Upon EPA approval of the Demonstration of Compliance Report for all Performance Standards and the completion of Annual Post-Construction Monitoring as described in (4) above, the Long-Term Monitoring period begins. Long-Term Monitoring will occur every five years; the first monitoring episode will occur five years after the last Post-Construction Monitoring event as described above. (SOW-OU2, VIIA)

6. As soon as the fifth year after the approval of the Demonstration of Compliance Report, OU2 may submit a request for Certification of Completion of Remedial Action (CD XV.51.a.).

7. OU2 continues O&M and Long-Term Monitoring until such time as a request for Certification of Completion of the Work is approved by EPA, after reasonable opportunity for review and comment by DEP (CD XV.52.a.).

For the wetland restoration to be considered in compliance with the performance standards described in Section VI.B. of the SOW-OU2 compliance with the performance standards must be achieved and maintained through the entirety of the Long-Term Monitoring required by the SOW until the Certification of Completion of Work is approved by EPA, after reasonable opportunity for review and comment by DEP.

## 1.3 REPORT ORGANIZATION

This O&M Plan has been organized to correspond with the four major requirement from the SOW-OU2 listed above. Part 2 contains the Post-Construction Environmental Monitoring Plan, Part 3 contains the ARAR Review, Part 4 contains the Post-Construction Wetlands Monitoring Plan, and Part 5 contains the Institutional Controls Review. A description of the anticipated routine O&M procedures and contingencies is included in Part 6. Part 6 also provides the O&M organization, inspection schedules and reporting procedures which will be followed during the O&M period.

## 2.0 POST-CONSTRUCTION ENVIRONMENTAL MONITORING PLAN

This plan summarizes the scope and procedures for accomplishing the post construction environmental monitoring required by the SOW-OU2. Section VIII.C.1.d.iii (c) i. (a) of the SOW-OU2 indicates that the environmental monitoring shall include "*sediment/soils, wetlands, and air monitoring adequate to monitor the effectiveness of the Second Operable Unit Remedy*". Results of the post construction environmental monitoring program will be reported to EPA in annual O&M reports. These reports are described further in Section 6.4 of this plan.

### 2.1 SURFACE WATER, SEDIMENT AND SOILS

Surface water, sediments, and wetland soils/sediments will be monitored during the period of O&M as described in the following subsections. Samples will be collected for analysis once a year during the first three years, and in year five. Upon completion of the first five year review in accordance with Section VI.A.5. of the SOW-OU2, sampling frequency will be reduced to one event every five years to be consistent with other ongoing monitoring requirements.

#### 2.1.1 Surface Water

A total of four surface water samples will be collected from reaches of the Unnamed Stream within the area of OU2 impacted by the RA construction. These samples will be collected to identify any stream related impacts to Middle Marsh and the Adjacent Wetland. The approximate locations for collection of the surface water samples are shown on Figure 2-1, and are generally located (1) where the Unnamed Stream enters the Adjacent Wetland, (2) where the Unnamed Stream exits the Adjacent Wetland, (3)

where the Unnamed Stream enters Middle Marsh, and (4) where the Unnamed Stream exits Middle Marsh. These locations were selected because they bound the areas where a more aquatic or semi-aquatic environment is to be restored. Surface water samples will be analyzed for pH and for PCBs. Both filtered and unfiltered samples will be analyzed. Analytical methods are presented in Table 2-1.

### 2.1.2 Sediment

A total of four sediment samples will be collected from reaches of the Unnamed Stream within the area of OU2 impacted by the RA construction. Sediment sampling locations will coincide with the surface water sampling location described above, and shown on Figure 2-1. Sediment samples will be analyzed for PCBs and for total organic carbon (TOC) in accordance with Section VII.A. of the SOW-OU2. Analytical methods are presented in Table 2-1.

### 2.1.3 Wetland Soils/Sediments

A total of two wetland sediment/soils samples will be collected from the Adjacent Wetland, and a total of four sediment/soils samples will be collected from Middle Marsh during each sampling event. During the performance evaluation period, the first three years after construction is complete, and in year five, sample locations will coincide with those required in the Wetland Restoration Monitoring Plan (Section 4 of this O&M Plan). Sample locations will be selected in late summer sampling rounds within the sampling quadrats established to evaluate the restoration of wetland vegetation. Areas with evidence of recent sediment deposition will be chosen. Sediment/soil sample locations will be located in the field and will be placed in the hollow, pool areas between the hummocks. Actual selection of the locations will consider probable depositional

areas, recent flood history for the Unnamed Stream, and results of previous sampling rounds. Samples will not be taken within ten feet of the Unnamed Stream, as stream monitoring is included above and in OU1.

Sediment/soil samples will be analyzed for PCBs. Analytical methods are presented in Table 2-1.

## 2.2 AIR MONITORING PROGRAM

A draft Air Monitoring Investigation Report was included in the 95% Pre-final RD as part of the draft Implementation Plan. This report evaluated the potential sources of fugitive emissions, and the resultant ambient air concentrations, and included an evaluation of these concentrations relative to ARARs and published exposure limits. This report concluded that the conditions during remedial action will result in ambient air concentrations that do not exceed ARARs or cause an unacceptable hazard to air quality. Because emissions during the post-closure period will be significantly less than during RA, continued air monitoring after the completion of construction is not proposed.

## 2.3 DATA EVALUATION AND CORRECTIVE ACTION

Collected surface water data will be compared to data from previous monitoring rounds, upstream data, and data generated under the O&M program for OU1. Trends will be noted and data which constitutes an outlier or aberration will be flagged for further evaluation. Based on these comparisons and evaluations, the need for corrective action will be reported, and potential corrective measures, if appropriate, will be proposed to EPA.

Similarly, collected sediments/soils data will be compared to data from previous monitoring rounds, OU1 data, and the site-specific Cleanup Standards and Performance Standards. Trends will be noted and data which constitutes an outlier or aberration will be flagged for further evaluation. Based on these comparisons and evaluations, the need for corrective action will be reported, and potential corrective measures, if appropriate, will be proposed to EPA.

## 2.4 PROGRAM MODIFICATION

In accordance with Section VII.A. of the SOW-OU2, the sampling frequency, analytical parameter, and monitoring reporting requirements may be modified by the U.S. Environmental Protection Agency (USEPA) in consultation with Massachusetts Department of Environmental Protection (MADEP). In accordance with Section VI.A.5. of the SOW-OU2, if sampling results and observed trends indicate that the effectiveness of the remedy has not changed with time, a written request to reduce the scope of environmental monitoring will be submitted for USEPA/MADEP approval.

## 3.0 ARAR REVIEW

Section VIII.C.1.d.iii (c)i(b) of the SOW-OU2 indicates that the O&M Plan shall include "compliance with other applicable state and federal requirements". Table 3-1, presents a synopsis of the ARARs from the OU2 Record of Decision and an analysis of each requirement's application to the activities that can reasonably be anticipated during the O&M period. An ARARs Analysis Report was prepared and submitted under separate cover as part of the 95% Design to address the compliance with these same requirements during remedial action.

## 4.0 PERFORMANCE STANDARDS, POST-CONSTRUCTION, AND LONG-TERM WETLANDS MONITORING

Following the approval by EPA, after a reasonable opportunity for review and comment by DEP, of the Certification of Completion of Construction, a program of post-construction wetlands monitoring will be initiated. The Post-Construction Monitoring will continue until the Demonstration of Compliance Report is approved by EPA, after reasonable opportunity for review and comment by DEP, at which point the Long-Term Monitoring program will begin. The Post-Construction Monitoring will be conducted annually, in late spring and in late summer, by a qualified wetlands biologist as approved by EPA. The objectives of the site inspections will be to document the status of the wetland restoration and to determine whether performance standards have been met.

### 4.1 PERFORMANCE STANDARDS

Although OU2 acknowledges the potential to re-establish forested wetlands in the long term, as was discussed in Section 1.2, the recognition that forested wetland cannot be fully restored in the short term requires that the interpretation of the Performance Standards originally specified in the SOW Section VI.B.3. be explicitly clarified as follows (interpretation underlined):

a. The herbaceous, shrub, and woody cover, as measured for bordering vegetated wetlands, as delineated in the pre-remedial investigation described in Section VI.A.1 of this SOW, at the end of the second growing season, within such restored wetland areas, shall achieve an overall seventy-five percent (75%) areal coverage for all wetland plant species collectively. It is not expected that tree species planted as part of the wetlands restoration will attain the height diameter

and areal coverage typical of the specimens currently existing in the wetlands for several years following planting.

b. If the herbaceous, shrub, and woody cover, as measured for bordering vegetated wetlands, as delineated in the pre-remedial investigation described in Section VI.A.1. of this SOW, at the end of the second growing season, within such restored wetland areas does not achieve an overall seventy-five percent (75%) areal coverage for all wetland species collectively, Settling Defendants shall submit a plan and timetable for initiating continued wetland restoration efforts to achieve 75% areal coverage. The Settling Defendants shall implement the plan, upon approval by EPA, after reasonable opportunity for review and comment by DEP.

c. The wetland areas within the Second Operable Unit, which have been identified as suitable Mystic Valley Amphipod habitat, as determined by its occurrence under pre-remediation conditions, shall be restored approximately to pre-remediation Mystic Valley Amphipod habitat conditions, with the exception that forested wetland areas which presently exist in Middle Marsh will not attain approximate pre-remediation conditions until the tree species planted as part of the wetland restoration have attained maturity. This [restoration of pre-remediation MVA habitat conditions] shall be determined by establishing that the Mystic Valley Amphipod occurs within areas of the Second Operable Unit.

d. If the presence of the Mystic Valley Amphipod is confirmed during the pre-remediation assessment, and its occurrence within the Second Operable Unit is not confirmed by the end of the third year after initiation of the wetlands restoration program, then, within sixty (60) days, the Settling Defendants shall

submit either: 1) a plan and timetable for re-establishing its presence within the Second Operable Unit. Upon approval of such plan by EPA, after reasonable opportunity for review and comment by DEP, the Settling Defendants shall implement the plan in accordance with the approved timeframes; or 2) a report which describes restoration efforts taken to date, the results of those efforts and a discussion of why, based upon the information that has been collected, the successful restoration of the Mystic Valley Amphipod, using restoration techniques ordinarily available, is impracticable. Upon approval of such report by EPA, after reasonable opportunity for review and comment by DEP, Settling Defendants' restoration obligation under this paragraph shall be considered complete.

OU2 may request that EPA certify the completion of Remedial Action as soon as the Performance Standards described in Section VI.B of the SOW and Section 1.3 of the Wetlands Restoration Plan have been achieved and maintained for at least five years. (CD, Paragraph 51). The restored wetland will continue to be monitored every 5 years in accordance with the Long-Term Monitoring Plan and the O&M Plan to ensure the long-term effectiveness of the wetland restoration program, as required by the SOW - Section VII and SOW-Section VI.A.5. Long-Term Monitoring will evaluate physical and biological attributes of the restored wetland against the long-term goals for these attributes as specified in the O&M Plan (SOW-OU2, VI.A.5).

## 4.2 POST-CONSTRUCTION AND LONG-TERM WETLANDS MONITORING

Post-Construction Monitoring, for a period of at least 5 years, will begin after EPA approval of the Certification of Construction Completion in order to determine if Performance Standards

have been met and maintained. The annual Post-Construction Monitoring will continue for at least five years until the Demonstration of Compliance Report is approved by EPA, after reasonable opportunity for review and comment by MADEP. Long-Term Monitoring of wetlands shall be conducted to ensure the long-term effectiveness of the wetland restoration program (SOW-OU2, VI.A.5). Long-Term Monitoring will begin during the fifth year after the later of (1) the completion of five years of Annual Post-Construction Monitoring and the approval of the Demonstration of Compliance Report described in Section IX.7 of the SOW, or (2) the approval of the Demonstration of Compliance Report described in Section IX.B.7 of the SOW. Long Term Monitoring will be performed in accordance with the requirements of the ROD (Section X.B.1.e.) and the SOW, Section VI.A.5 of the SOW-OU2 specifies the basis upon which meeting the Performance Standards and ensuring the long-term effectiveness of the wetland restoration program will be evaluated. As required by the ROD (Section X.B.1.d.), the possibility of using the Spotted Turtle and the Mystic Valley Amphipod as indicators of the success of restoration was considered. As indicated on the Remedial Design Work Plan (Dames & Moore 1995a) the Mystic Valley Amphipod will be used as a biological indicator species. Although the Spotted Turtle was casually observed during the RI (Metcalf & Eddy 1991a), there was no study conducted or required that would have developed the information on the Spotted Turtle necessary to form the baseline of a monitoring study. Annual Post-Construction wetlands monitoring will include evaluating physical and biological attributes of the restored wetland areas in accordance with the O&M Plan.

The Long-Term monitoring results will be used in determining wetland restoration effectiveness(SOW-OU2, VI.A.5). In effect, the monitored attributes and their companion goals will permit an evaluation over time of whether the ecological community is succeeding along the intended trajectory. Failure to meet a goal for one or more attributes is not necessarily cause for corrective action. Rather, a logical analysis should occur that evaluates the quantitative difference between the monitoring results and the attribute goal; the underlying reason(s) for that

difference; whether the difference is meaningful in terms of achieving the project objectives; and whether and what type(s) of corrective action is dictated by the failure. SOW-OU2, Section VI.A.6 states: "Settling Defendants shall reimplement wetlands restoration if EPA determines, after reasonable opportunity for review and comment by DEP, based on subsequent assessment results, that the performance standards of the wetlands restoration have not been met due to ineffective wetlands restoration. Settling Defendants shall perform periodic maintenance (e.g. planting) as determined necessary by EPA, after reasonable opportunity for review and comment by DEP, to ensure final restoration of the designated wetland areas".

### 4.2.1 Physical Indicators

Monitoring of hummocks and wetlands hydrology physical attributes will take place annually during the Post-Construction Monitoring period outlined above, and in accordance with the Long-Term Monitoring schedule.

#### 4.2.1.1 Hummocks

As stated in the Wetlands Restoration Plan (Appendix G of the Final RD Implementation Plan), four representative 100-foot-square plots will be established within Middle Marsh. A visual estimate of the relative proportion of hummocks to hollows will be completed in each plot. In addition, a qualitative assessment of the condition of the hummocks, including a general description of whether the hummocks have maintained their integrity and whether they have been colonized by non-invasive species, will be conducted. According to the Baseline Wetland Characterization Report (D&M and Earthplans, 1996a), hummocks comprise about 25% of the area of the forested and about 46% of the scrub-shrub wetlands of Middle Marsh. The long-term goal for this attribute is to maintain greater than 25% mean areal coverage of hummocks in the plots.

#### 4.2.1.2 Wetlands Hydrology

In order to measure water levels in the root zones of the restored wetlands, six stations have been established, two of which are in areas which will not be excavated, three of which are in areas of excavation within Middle Marsh and one of which is in the area of excavation of the Adjacent Wetland (Figure 4-1). The piezometer locations have been chosen to represent varying cover types and distances from the course of the Unnamed Stream. The objective of this monitoring program is to determine whether restored wetland sediments, particularly in the root zones of restored vegetation, replicate the water retention characteristics of the pre-existing wetland sediments.

Piezometers were installed in August 1996 as depicted in Figure 4-2. Two piezometers are in wetland areas which will not be excavated, three are in the portion of Middle Marsh that will be excavated, and one is in the Adjacent Wetland. Measurements of depth to groundwater were taken in August and October, 1996 and four times in 1997 at 6 week intervals between mid-April and October. After restoration construction is complete, disturbed piezometers will be reinstalled and measurements will be taken annually four times per year between April and October during the Post-Construction Monitoring period outlined above. During the Long-Term Monitoring period, the monitoring will be performed every 5 years four times per year between April and October. Water levels in the piezometers will be measured after a period of at least two days without rain. Results of measurements in the piezometers will be compared to one another and to OU1 monitoring wells MW-6A, MW-7, MW-20 and MW-10A and reported in the annual data reports to U.S. EPA and MADEP.

According to the United States Army Corps of Engineers (Corps) definition of a wetland, the depth to groundwater and/or saturated soils within a wetland should be no more than 12 inches for at least two weeks during the growing season (Corps, 1987). The long-term goal for the wetland hydrology attribute is the presence of groundwater and/or saturated soils within 12 inches of the wetland surface in each piezometer for at least three of the first five years and each fifth year thereafter. If this goal is not achieved, reasons for the low water levels, such as drought conditions, will be provided.

#### 4.2.1.3 Hydric Soils

A wetland must contain hydric soils to meet the definition of a federal wetland (Corps, 1987). To determine if the restored wetlands meet the federal wetland definition, a complete soil profile description will be produced at the end of the fifth growing season and subsequently every five years. The soils will be evaluated by conducting shallow soil borings (18 to 24 inches deep) within each of the permanent vegetation sampling quadrats. The soil profiles will be conducted in accordance with the soil profile description form in Appendix C of the O&M Plan. The goal for restored wetland soils will be a trend for the soils from all ten borings to meet the definition of hydric within ten years. Version 2 of the *Field Indicators of Hydric Soils in New England* (NEIWPCC, 1998) will be used to determine if the soil profile descriptions qualify as hydric.

### 4.2.2 BIOLOGICAL INDICATORS

Biological monitoring will take place annually during the Annual Post-Construction Monitoring program. During the Long-Term Monitoring program, the monitoring will take place every 5 years. Biological attributes monitoring will take place at the end of the growing season, late August or early September, in each year.

Within the Adjacent Wetland, two sampling quadrats will be established in each of the two cover types that were restored, scrub-shrub and emergent. Within each of the cover types sampling quadrats, plant cover and dominance will be visually estimated and recorded for each vegetative stratum, i.e., scrub-shrub and herbaceous following the methodology used in the Wetlands Baseline Characterization Report, i.e., the New England Division Army Corps of Engineers (Corps. 1987, 1991, 1995) wetland delineation guidelines. Within Middle Marsh four representative 100-foot-square quadrats, corresponding to the original grid system, will be established. In each of the four 100-foot-square grids a visual estimate of relative proportion of hummocks to lower lying open areas will be made. In addition, one hummock area and one pool, or hollow, area will be selected from each of the four 100-foot-square grids, for evaluating plant species, relative percent areal coverage and dominance using the same methodology used in the Wetlands Baseline Characterization Study (Dames & Moore and Earthplans 1996), i.e., the New England Division of Army Corps of Engineers (Corps. 1987, 1991, 1995) wetland delineation guidelines. Sampling quadrats in both the Adjacent Wetland and Middle Marsh will be documented by photographs from fixed stations.

The biological monitoring results from the first two full growing seasons will be evaluated to determine if an overall 75% areal coverage for all wetland species collectively is achieved in accordance with 310 CMR 10.53(3)(q). If the measured percent cover meets or exceeds the 75% performance standard, the wetlands restoration will be considered to have met the Performance Standard specified in Section VI.B.3.a of the SOW in the Demonstration of Compliance Report submitted to EPA for approval.

#### 4.2.2.1 Survival Rates of Planted Species

To assess the potential of the restored site to develop into a forested wetland, the mean survival rates of the planted tree and shrub species will be assessed within the quadrats annually during the Post-Construction Monitoring period. During the Long-Term Monitoring program, this assessment will take place every five years. The goal for this attribute is that at least 80% of the plantings of each species in the restored wetlands should be viable five years after planting. The 80% may be comprised of both plantings and volunteers of the species. For example, if 100 red maples are planted in the wetland, at least 80 red maples should be alive in the wetland, whether planted or volunteer. Monitoring curves will be plotted for each species. Causes for plant mortality, such as animal damage, will be noted and remedied, as possible.

#### 4.2.2.2 Tree Growth

To assess the potential of the restored wetland to develop into a forested wetland, the condition of planted tree species in the four 100-foot-square plots in Middle Marsh will be monitored. All tree heights, diameters at breast height (dbh), and canopy areas will be measured using appropriate methods. The goal for this attribute is for mean tree height and dbh for planted stock to increase at least 20% from the original planting height and dbh every 5 year interval.

#### 4.2.2.3 Vegetative Diversity

The Wetland Baseline Characterization Report documents at least 30 woody and 40 herbaceous wetland species in the existing wetlands. Vegetative diversity will be monitored at the end of the growing season during each monitoring event with the goal of demonstrating an ever increasing trend from the 15 woody and 10 herbaceous planted species with at least one woody and one herbaceous non-invasive wetland species added every five years.

#### 4.2.2.4 Plant Community

As stated in the SOW-OU2, the herbaceous, shrub, and woody relative cover at the end of the second growing season must achieve an overall 75% areal coverage of wetland plant species, consistent with 310 CMR 10.53(3)(q). The quadrats will be monitored to evaluate the areal coverage of wetland plant species. If it is established that an overall 75% areal coverage is achieved at the end of the second full growing season after completion of construction, the wetlands restoration will be considered to have met the Performance Standard specified in Section VI.B.3 of the SOW in the Demonstration of Compliance Report submitted to EPA for approval.

In order to assess the success of the restoration during Long-Term Monitoring (SOW-OU2, VI.A.5), the quadrats will be monitored and the plant community evaluated. The goal is to ensure that greater than 50% of the dominant plants, exclusive of invasive species, should be wetland species. A list of invasive species in Massachusetts is provided in Appendix B.

#### 4.2.2.5 Mystic Valley Amphipod

Monitoring the Mystic Valley Amphipod will be conducted using similar methodology to that employed in the Pre-Design Investigation for the Mystic Valley Amphipod (Dames & Moore 1995d). During the Annual Post Construction Monitoring of wetlands within Middle Marsh and the Adjacent Wetland, representative sampling will be conducted in the spring from mid-April to mid-May to evaluate whether the Mystic Valley Amphipod is present.

Two sweeps, approximately 3-feet-long, will be made in representative wetland areas using a mesh dip net approximately 10 inches in diameter. These areas will include those newly restored as well as those that were not impacted by excavation. At least two areas in the Adjacent

Wetland and five areas in Middle Marsh will be sampled. The following information will be recorded in the field:

1. condition of sampling site, including clarity of water,
2. presence of emergent vegetation, and
3. presence of organic layer at bottom of pool areas.

Any amphipods collected will be retained and returned to the laboratory for identification. Identifications of amphipods will be verified by Mr. Douglas Smith who verified Mystic Valley Amphipod identification in the baseline study of the presence of the Mystic Valley Amphipod (Dames & Moore 1995d). If it is established that the Mystic Valley Amphipod occurs within areas of the Second Operable Unit at the end of the third year after EPA approval of the Certification of Construction Completion, the wetlands restoration will be considered to have met the Performance Standard specified in Section VI.B.3.c of the SOW in the Demonstration of Compliance Report submitted for EPA approval.

## 4.3 OTHER WETLAND CHARACTERISTICS

In addition to implementing the requirements of the monitoring program, the following information will be collected during sampling events in both the spring and late summer.

- A qualitative assessment of the growth and health of the plants used for restoration including observations of root, shoot, and branch growth and evidence of flowering. Any evidence of stress will also be documented.
- Photographic documentation of the restored sites from fixed stations. These stations will be selected after restoration has been completed to incorporate any variability that won't be obvious until after restoration is complete.

- Assessment of invasive species. Since one of the objectives of the restoration plan will be to limit the invasion of opportunistic species, e.g., Phragmites), purple loosestrife, cattail and grape, their presence will be noted and they will be removed either by cutting or by controlled spraying with an herbicide, e.g., Rodeo (see Section 4.3.).

- Assessment of erosion. Erosion will be assessed by measuring grade stakes that were placed during planting of the wetlands vegetation. (See Section 3.4).

## 4.4 CORRECTIVE MEASURES

As stated previously, the monitoring results and guidelines will be used in determining wetland restoration effectiveness during Long Term Monitoring (SOW-OU2, VI.A.5). In effect, the monitored attributes and their companion goals will permit an evaluation over time of whether the ecological community is succeeding along the intended trajectory. Failure to meet a goal for one or more attributes is not necessarily cause for corrective action. Rather, a logical analysis should occur that evaluates the quantitative difference between the monitoring results and the attribute goal; the underlying reason(s) for that difference; whether the difference is meaningful in terms of achieving the project objectives; and whether and what type(s) of corrective action is dictated by the failure (SOW-OU2, VI.A.6). SOW-OU2, Section VI.A.6 states: "Settling Defendants shall reimplement wetlands restoration if EPA determines, after reasonable opportunity for review and comment by DEP, based on subsequent assessment results, that the performance standards of the wetlands restoration have not been met due to ineffective wetlands restoration. Settling Defendants shall perform periodic maintenance (e.g., planting) as determined necessary by EPA, after reasonable opportunity for review and comment by DEP, to ensure final restoration of the designated wetland areas".

In addition, certain types of problems which may be detected during the site visits will be corrected using the measures discussed in this section. Such potential problems will likely fall into one of the following categories:

- Death or failure of plants to properly grow.
- Excessive plant damage caused by animals.
- Invasion of opportunistic plant species into restoration areas.
- Erosion of an amount of topsoil/backfill that modifies the topography of restoration areas to a degree that it would affect the success of restoration in those areas.
- Temporary interference with hydrological regimes of Middle Marsh.

### 4.4.1 Replacement of Plants

Any dead or moribund plants will be replaced at the earliest possible time consistent with the growing season, as necessary, to achieve a minimum of the original plant density. Any bare areas observed will be identified and replanted or reseeded as necessary.

### 4.4.2 Invasive Species

Since several opportunistic species, such as Phragmites, cattail, and purple loosestrife, are currently found in the Adjacent Wetland and Middle Marsh, there is a good possibility that the newly restored wetland areas will be invaded by them in the initial stages of the wetland restoration. Because these species are typically more successful at colonizing newly disturbed areas, they must be controlled or they will dominate the newly restored areas to the exclusion of

other species. Since this is an undesirable situation, invasion of these species will be controlled using both manual removal and selective use of herbicide.

Invasive species will therefore be manually removed during each of the monthly site inspections. If manual removal is not successful, an herbicide such as Rodeo will be utilized. If an herbicide is used, it will be applied manually, by wiping the plants and not by spraying. A Massachusetts permit for herbicide application will be obtained in anticipation of the necessity to use it.

### 4.4.3 Topsoil Replacement

Minor repairs of eroded topsoil will be made using hand tools and wheelbarrows. If unanticipated, uncontrolled erosion occurs that requires heavier equipment to re-access the restored areas, USEPA and MADEP will be consulted with to evaluate damage and develop an action plan to restore damaged areas in a manner that minimizes the impact to restored wetland areas.

### 4.4.4 Operable Unit One Ground Water Treatment and Sedimentation Ponds

As OU1's plan for Management of Migration, Scope of Work for Operable Unit 1, (SOW- OU1) (USEPA 1991) requires a ground water treatment system using pump and treat, there is the potential that the operation of such a system could have an effect on the water table in the restored wetlands. This potential is considered minimal, particularly since OU1 will be installing a slurry cutoff wall between the ground water extraction system and the wetlands. However, if a water table drawdown does occur, it could affect the plants currently growing in the restored wetlands as well as the species composition of those colonizing the restored wetlands, i.e., it would establish conditions that may favor upland plants. Such a situation is beyond the control of AVX.

Similarly, since the wetlands in Middle Marsh and the Adjacent Wetland depend upon periodic flooding to maintain their character, the use of a sedimentation pond by OU1 could limit this periodic flooding. While this may be desirable to limit the potential for erosion during the early stages of wetland restoration, it would have a negative effect on the success of restoration in the long-term. The best situation for the long-term is if there would be no modification of natural flooding events in Middle Marsh and the Adjacent Wetland.

## 4.5 REPORTS

As required by the SOW-OU2 (Section IX.B.1.d.ii.), annual reports will be submitted for USEPA review regarding the results of monitoring activities for physical and biological indicators.

The monitoring data to be collected from the restored wetlands will be compared against the goals described above and summarized in the following table. Monitoring reports will be prepared to document trends that indicate the restored wetlands are developing, through the natural dynamics of habitat succession, into the forested and scrub-shrub wetlands that presently exist.

| **Wetland Attributes** | **Goals** |
|---|---|
| *Physical Indicators* | |
| 1. Hummocks | Maintain greater than 25% mean areal coverage of hummocks in the sampling plots. |
| 2. Hydrology | Groundwater and/or saturated soils should be within 12 inches of the wetland surface for two weeks in each piezometer in the restored wetlands at least three of every five years. |
| 3. Soil Development | Soils from all ten borings should show a trend to meet the definition of hydric within ten years. |

| Wetland Attributes | Goals |
|---|---|
| *Biological Indicators* | |
| 4. Survival Rates of Planted Trees and Shrubs | At least 80% of the original number of plantings of each species should be viable five years after planting. The 80% may be comprised of both plantings and volunteers of the species. |
| 5. Tree Growth | Mean tree height and diameter (dbh) for planted trees should increase at least 20% from the original planting height and dbh every 5 year interval. |
| 6. Vegetative Diversity | Demonstrate an ever increasing trend up from the 15 woody and 10 herbaceous planted species, by providing at least one additional woody and one additional herbaceous non-invasive wetland species every 5 years. |
| 7. Plant Community | (a) Herbaceous, shrub, and woody relative cover at the end of the second growing season must achieve an overall 75% areal coverage of wetland plant species. (Also a Performance Standard under Section VI.B.3.a of the SOW)<br><br>(b) To ensure the area continues to meet the federal wetland definition, greater than 50% of the dominant plants, exclusive of invasive species, should be wetland species |
| 8. Mystic Valley Amphipod | The Mystic Valley Amphipod must occur within areas of the Second Operable Unit by the end of the third year after wetland construction. (Also, a Performance Standard under Section VI.B.3 of the SOW) |

The O&M report after the third growing season will summarize and interpret all of the monitoring data and analyze compliance with the Performance Standards contained in

Section VI.B of the SOW-OU2. The Demonstration of Compliance Report containing such data can then be submitted to EPA for approval.

Each Annual O&M Report will include a summary of the status of the wetland attributes and a comparison of the monitoring results to the specified goals after appropriate monitoring periods. In addition, separate sections of the report will discuss:

- Measurements of vegetative diversity through colonization of restored wetland areas by "volunteer" species,

- Measurements of tree height and diameter and a qualitative assessment of the growth and health of plants and grasses used for restoration,

- Measurements of the areal coverage of hummocks and a qualitative description of the condition of the hummocks and their vegetation,

- Measurements of soil development and a qualitative description of hydrological characteristics in the restored wetlands focusing on the ability of the restored wetland sediments to maintain moisture,

- A tabulation and evaluation of piezometer data,

- Measurements of the survival rates of planted species and areal coverage of wetland plant species,

- Documentation of the presence or absence of the Mystic Valley Amphipod at sampling stations both within newly restored wetland areas and in wetland areas outside of the newly restored wetland.

The monitoring reports will also document:

- Any corrective measures taken to restore the Mystic Valley Amphipod to the areas of the Second Operable Unit.

- Any corrective measures taken to achieve the level of cover required by the SOW Performance Standards.

- Any corrective actions taken to enhance the trend towards achieving the long-term effectiveness of the wetland restoration(SOW-OU2, VI.A.6).

- Any corrective measures taken to control invasion of opportunistic species.

If the Performance Standards in the SOW-OU2 are not achieved within the timeframe specified in the SOW-OU2, a plan for achieving the Performance Standards will be submitted to the agencies for review and approval and monitoring inspections and reports continued as specified in that plan (SOW-OU2;VI.B, VI.A.6).

## 5.0 INSTITUTIONAL CONTROLS

Section III.6. of the SOW-OU2 states that the remedy shall include "institutional controls to prevent future residential use and non-recreational commercial use, and to restrict access to Middle Marsh and the Adjacent Wetland." Access restrictions during the post-closure period will include maintenance of the site security fence. Institutional controls, as further defined in Section VII.F. of the SOW-OU2, are to include City of New Bedford actions to restrict ground water use, and deed restrictions on the property within OU2.

The SOW-OU2 addresses institutional controls in other sections as well. The closure requirements, Section VII.G.3. state that "Settling Defendants shall conduct yearly reviews to monitor implementation of the institutional controls specified in Section VII.F. of this SOW and to check on the adequacy of the institutional controls." Section VIII.C.1.d.iii.(c)i.(d) of the SOW-OU2 reiterates that the O&M Plan shall include "submittal of yearly reports in accordance with Section VII.G.3. of this SOW that describe the results of the monitoring of implementation and effectiveness of the institutional controls specified in Section VII.F. of this SOW."

Accordingly, O&M activities will be conducted during the post-closure period to address two components: 1) maintenance of measures to restrict site access and 2) inspections for compliance with institutional controls such as deed restrictions.

### 5.1 SITE SECURITY INSPECTIONS

The site security measures (fence and warning signs) installed in accordance with the Phase II Site Security Plan (Dames & Moore, 1996) will be relocated at the conclusion

of construction to surround only the Middle Marsh and Adjacent Wetland. These remaining security measures will be maintained to restrict access in the post-closure period. The fences, gates and warning signs will be inspected on a quarterly basis. Necessary repairs and replacement of fencing and warning signs will be completed as quickly as possible, with minor hand repairs completed during the inspection. Results of the site security inspections will be reported to USEPA and MADEP on an annual basis.

## 5.2 INSTITUTIONAL CONTROL COMPLIANCE VERIFICATION

An inspection of the site will be conducted once each year to verify that the deed restrictions, ground water use restrictions and other requirements of institutional controls have not been violated and remain effective. In addition to the site inspection, the appropriate officials of the City of New Bedford and/or the Registry of Deeds will also be contacted as necessary. Results of the institutional control compliance monitoring will be documented annually to USEPA and the MADEP. If any institutional controls are found to be inadequate, USEPA will be notified within 30 days of the annual inspection, in accordance with Section VII.G.3. of the SOW-OU2. In accordance with Section VII.G.3 of the SOW-OU2, AVX may elect to request a reduction in the frequency of inspection or to demonstrate that such inspections are no longer needed.

# 6.0 OPERATION & MAINTENANCE PROCEDURES

## 6.1 ORGANIZATION

The City of New Bedford (City) will be responsible for implementation of the O&M Plan. Dames & Moore, acting on behalf of AVX, will review reports resulting from the O&M Plan. The City will conduct site security, institutional controls, inspections, environmental monitoring and wetland restoration evaluations. Annual reports during the O&M period will be prepared and submitted by the City and reviewed by Dames & Moore acting on behalf of AVX.

The City's Project Manager will have overall responsibility for management of the O&M program. Site inspections, maintenance operations and monitoring activities will be performed by City personnel chosen on the basis of relevant experience for performing such work or by a qualified contractor, however wetlands monitoring, maintenance, and assessments will be conducted by a qualified wetlands biologist as approved by EPA. Inspection and monitoring checklists will be completed for each event, signed by the authorized field supervisor or contractor representative, and verified by the City's Project Manager. Corrective measures, maintenance and repair work will be undertaken promptly by the appropriate field supervisor or contractor representative and documented in the annual report. Dames & Moore, on behalf of AVX, will provide quality assurance through review of the annual reports prepared by the City.

## 6.2 INSPECTION AND MONITORING SCHEDULE

Post-closure activities for OU2 will begin upon USEPA's approval of the Final Remedial Construction Report and Certification of Completion of Construction in accordance with Section IX.B.6 of the SOW-OU2. O&M activities and monitoring will continue until Work is complete in accordance with Paragraph 52 of the Consent Decree. The City and AVX may elect

to demonstrate that O&M activities are no longer required after the first Long-Term Monitoring episode and request USEPA approval to modify or discontinue such activities.

During the first five years following completion of construction, site inspections as described in this section will be undertaken on a quarterly basis. The inspection events will vary by season, as described in the following subsections.

### 6.2.1 Spring Inspection/Monitoring

In addition to a general inspection of site conditions, during the annual Post-Construction Monitoring Period, the Spring inspection will include wetland evaluation, including MVA monitoring, in accordance with Section 4 of this O&M Plan, and inspection of site security measures in accordance with Section 5 of this O&M Plan. With the beginning of Long-Term Monitoring and for the remainder of the O&M period, the spring event will include only the inspection of general conditions, MVA monitoring and site security measures. Spring inspections will take place in late April or early May.

### 6.2.2 Summer Inspection/Monitoring

In addition to a general inspection of site conditions, during the annual Post-Construction Monitoring Period, the summer inspection will include environmental monitoring in accordance with Part 2 of this O&M Plan, wetland evaluation in accordance with Part 4 of this O&M Plan, and inspection of site security measures in accordance with Part 5 of this O&M Plan. Summer inspections will take place in August.

### 6.2.3 Fall Inspection

Fall events will include a general inspection of site conditions, field verification of Institutional Controls and inspection of site security measures in accordance with Section 5 of this O&M Plan. Fall inspections will take place in November.

### 6.2.4 Winter Inspection

Winter events will include a general inspection of site conditions, and inspection of site security measures. Winter inspections will be eliminated after the third winter of the O&M period. Winter inspections will take place in February.

## 6.3 INSPECTION AND MAINTENANCE PROCEDURES

The OU2 areas, Middle Marsh and the Adjacent Wetland, will be inspected and maintained throughout the O&M period in accordance with the above schedule. Sample inspection checklists and maintenance schedules for each component are included in Appendix A. The individual components of the seasonal inspections will be completed using the following procedural guidelines.

### 6.3.1 General Site Conditions

The site will be inspected and general site conditions evaluated, particularly for:

- Visible debris, litter and solid waste
- Integrity of surface features and evidence of erosion
- Loss of vegetative cover or growth of undesirable species in upland areas

- Accumulation of debris or obstructions in waterways

Minor maintenance and hand repairs, such as debris removal, pruning, mowing, weeding or raking will be completed during the inspection. Conditions requiring more extensive repair or maintenance will be reported to the City's Project Manager within 24 hours of the inspection. Subsequent corrective measures will be undertaken within 10 days, or on an alternate schedule approved by the EPA Remedial Project Manager.

### 6.3.2 Environmental Monitoring

Environmental monitoring will be conducted in accordance with an approved Sampling and Analysis Plan (SAP). The SAP will be included in draft as part of the RAWP. Upon approval by USEPA, in consultation with MADEP, the SAP will be appended to the final O&M Plan for implementation.

In addition, the City's O&M Project Manager will request, on an annual basis, the results of the long-term monitoring conducted during the preceding year by OU1. Applicable OU1 monitoring data will be tabulated along with OU2 data and used in data evaluation.

### 6.3.3 Wetland Evaluation

Specific procedures for the long-term monitoring and maintenance of the restored wetland have been included in Section 4, above, and in the Wetlands Restoration Plan. Sample inspection checklists and maintenance schedules for wetlands restoration are presented in Appendix A.

### 6.3.4 Site Security

Site security inspections will be conducted consistent with the Phase II Site Security Plan (Dames & Moore, 1996). Quarterly inspections of the entire length of fence will be conducted. The presence of warning signs every 100 feet will be verified.

Minor maintenance and hand repairs, such as lock replacement and simple fence fabric mending will be completed during the inspection. Conditions requiring more extensive repair or maintenance will be reported to the City's Project Manager within 24 hours of the inspection. Subsequent corrective measures will be undertaken promptly.

### 6.3.5 ARAR and Institutional Control Compliance

The general site inspection will once each year specifically focus on inspections for violations of ARARs or Institutional Controls. In accordance with Section VII.F of the SOW-OU2, the O&M team will verify both in the field, and with the appropriate officials of the City, that:

- The area within OU2 is not being developed for any use other than as a golf course;
- Ground water wells have not been installed within the OU2 area, and ground water underlying the OU2 area is not being used for drinking water;
- Intrusive earthwork activities below the top six inches of soil, are not being undertaken within OU2;
- Remedial measures installed during RA have not been disturbed during the post-closure period. Such remedial measures may include monitoring wells, sampling stations,

surveying benchmarks, or other facilities necessary for the continued long-term operation and maintenance of remedial measures, and

- Removal of potentially contaminated sediments or soils from the property within OU2 has not occurred.

A sample Institutional Control checklist is included in Appendix A. All violations of Institutional Controls will be reported to the City's Project Manager within 24 hours, and to USEPA within 30 days. Subsequent corrective measures will be proposed and implemented promptly.

## 6.4 OPERATION & MAINTENANCE REPORTING

An annual O&M report will be prepared and submitted to USEPA and MADEP no later than the 30th of January of each year, beginning with the first January after USEPA approves the Final Remedial Construction Report. Annual reports will include the following details.

- A description of sampling events during the previous year, including sampling dates, and sample locations shown on a map of the site;
- Tables showing laboratory analytical results, including comparisons with any environmental standards, performance standards and data collected by OU1 when available.
- Evaluation of any data collected, with statistical analysis where appropriate, indicating any trends or anomalies;
- Description of site conditions during inspections;
- Description of all corrective measures taken during the previous year; and
- Description of the wetland restoration evaluation in accordance with Section 4, above.

Appropriate completed inspection checklists and maintenance schedules will be appended to the annual O&M reports.

In year five of the O&M period, and if necessary every five years thereafter, a "Five Year Review" report will be prepared in accordance with Section 121 (c) of CERCLA and the National Contingency Plan (40 CFR Section 300.430(f)). The format and content of the Five Year Review Report will be proposed for USEPA approval as part of the submission of Final O&M Plan.

## 6.5 OPERATION & MAINTENANCE COST ESTIMATE

Section 7.1.2 of the RD Work Plan indicated that an annual budget estimate would be included in the O&M Plan. The RD Work Plan included this provision to be consistent with Section 2.3.3 and Exhibit B-1 of the Superfund Remedial Design and Remedial Action (RD/RA) Guidance (OSWER Directive 9355.0-4A). The RD/RA Guidance reflects the need for a cooperative agreement with the state in the event that the state needs to assume the O&M activities and costs. OU2 O&M is the responsibility of the City. The likelihood is great that the work will be performed by the City itself, although the City may elect to contract the work to others. Given this situation, many of the cost inputs, e.g., labor rates, cannot be fixed at this time. Provision of the O&M annual budget estimate, therefore, is deferred until submittal of the final O&M Plan.

## 7.0 REFERENCES


Dames & Moore. 1998. "Final Remedial Design Implementation Plan Appendix H Wetlands Restoration Plan, Sullivan's Ledge Superfund Site, New Bedford, Massachusetts." Prepared for AVX Corporation.

Dames & Moore. 1996b. "Phase II Site Security Plan, Second Operable Unit, Sullivan's Ledge Superfund Site." Prepared for AVX Corporation.

Dames & Moore and Earthplans. 1996a. Wetland Baseline Characterization Report (Appendix G to 30% Remedial Design Report), Sullivan's Ledge Superfund Site, New Bedford, Massachusetts." Prepared for AVX Corporation.

New England Interstate Water Pollution Control Commission (NEIWPCC). 1998. Field Indicators for Identifying Hydric Soils in New England. Version 2.

United States Army Corps of Engineers, New England Division. 1987. Wetlands Delineation Manual.

United States Army Corps of Engineers, New England Division. 1991. "Wetland Delineation Standards."

United States Army Corps of Engineers, New England Division. 1995. Performance Standards and Supplemental Definitions for Use with the 1987 Corps Manual.

United States Environmental Protection Agency. 1986. "Superfund Remedial Design Guidance." OSWER Directive 9355.0-4A.

United States Environmental Protection Agency. 1992a. "Remedial Design/Remedial Action Statement of Work, Sullivan's Ledge Superfund Site, Second Operable Unit."

United States Environmental Protection Agency. 1992b. v.s. v. AVX Corporation, et al., Civil Action No. 93-10104-K. Consent Decree, Sullivan's Ledge Superfund Site, Second Operable Unit.

United States Environmental Protection Agency. 1991. "Remedial Design/Remedial Action Statement of Work, Sullivan's Ledge Superfund Site, First Operable Unit."

## TABLE 1-1

## SYNOPSIS OF ENVIRONMENTAL MONITORING PROGRAM REQUIREMENTS

| Section IX.B.1.d. REQUIREMENT | HOW ADDRESSED |
|---|---|
| i.(a) Monitoring of air emissions | 1. During excavation, storage, treatment and disposal activities, air monitoring will be addressed in accordance with the Air Monitoring Program outlined in Section V.A. of the SOW-OU2 and submitted in the Final RD Implementation Plan and the Division 2 Technical Specifications.<br><br>2. After completion of construction, air monitoring will be addressed in accordance with Section 2 of the O&M Plan. |
| i.(b) Monitoring of sediment/soils, surface waters, dewatering effluent to determine compliance with cleanup and performance standards. | Demonstration of compliance with performance standards is included in the Closure Plan, a part of the Final RD Implementation Plan required in accordance with Section VIII.C.1.d.iv. (d). |
| i.(c) Assessment of wetlands to determine the success of wetlands restoration program. | Short-term wetland restoration monitoring is presented in the Wetland Restoration Plan, Appendix H of the Final RD Implementation Plan, and post construction wetland restoration monitoring is included as Part 4 of this O&M Plan. |

| Section IX.B.1.d. REQUIREMENT | HOW ADDRESSED |
|---|---|
| i.(d) Testing (for PCBs) of soils to be used as fill in wetlands restoration. | Soils testing during construction is included in the Excavation Plan, a part of the Final Implementation Plan required in accordance with Section VIII.C.1.d.iv. (d) and submitted under separate cover as part of the Final RD. Soils testing is also addressed in Division 2 Technical Specifications. |
| i.(e) A schedule for monitoring all required media. | 1. The schedule for monitoring during construction will be included in the RA Work Plan.<br><br>2. The post-construction monitoring schedule is addressed in Section 2, and in Section 6 of this O&M Plan |
| i.(f) List of analytes, analytical methods and detection limits. | 1. The analytical program for monitoring during construction is required by the Division 2 Technical Specifications of the Final RD to be included in the RA Work Plan.<br><br>2. The post-construction monitoring analytical program is addressed in Section 2 of this O&M Plan |
| i.(g) Work plans for monitoring activities developed in accordance with Sections IV, V, VI, and VII of the SOW-OU2 | Work plans for monitoring activities are divided between the RD or RA documents with which the activities are associated. For example, this O&M Plan constitutes the comprehensive work plan for post construction monitoring. |

| Section IX.B.1.d. REQUIREMENT | HOW ADDRESSED |
|---|---|
| i.(h) Description of criteria to be used to interpret monitoring data. | 1. The data evaluation criteria for monitoring during construction is included in the Division 2 Technical Specifications and in the Implementation Plan of the Final RD.<br><br>2. The post-construction monitoring data evaluation criteria are addressed in Section 2, and elsewhere in this O&M Plan |
| i.(i) Description of sampling locations for each media | 1. The sampling locations for monitoring during construction will be included in the RA Work Plan.<br><br>2. The sampling locations for post-construction monitoring are addressed in Section 2 of this O&M Plan |
| i.(j) Provision that monitoring shall be consistent with the sampling points, sampling frequencies, analytical parameters and duration of sampling as described in the SOW-OU2. | The SOW-OU2 requirements have been used as the foundation for the short term and long-term monitoring programs, and the appropriate sections of the SOW-OU2 are referenced throughout. |
| i.(k) A time schedule for submitting monitoring reports. | 1. The schedule for reporting during construction will be included in the RA Work Plan.<br><br>2. The post-construction reporting schedule is addressed in Section 6 of this O&M Plan. |

| Section IX.B.1.d. REQUIREMENT | HOW ADDRESSED |
|---|---|
| ii. Requirements for the content of monitoring reports. | 1. The monitoring report content and format for monitoring during construction will be included in the RA Work Plan.<br><br>2. The post-construction monitoring report content and format is addressed in Section 6 of this O&M Plan |

## TABLE 2-1

## ANALYTICAL METHODS, LONG-TERM ENVIRONMENTAL MONITORING

| Parameter | Matrix | Analytical Method |
|---|---|---|
| PCBs | surface water | SW8082A |
| | sediment | SW8082A |
| pH (field test) | surface water | USEPA 150.1 |
| Total Organic Carbon | sediment | Llyod Kahn Method |

**Notes:**

SW - *Test Methods for Evaluating Solid Wastes, Physical and Chemical Methods, SW-846 Third Edition, UpDate II*, USEPA, September 1994, or most recent edition.

USEPA - *Method for the Chemical Analysis of Water and Wastewater, USEPA 600-4-70-020*, USEPA, 1983.

Llyod Kahn Method - *Determination of Total Organic Carbon in Sediment*, USEPA Region II, Environmental Sciences Division, Monitoring Management Branch, Edison, New Jersey, July 27, 1988.

**TABLE 3-1**

**ARARs REVIEW DURING OPERATION & MAINTENANCE**

| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| Clean Water Act (CWA) Section 404(b)(1) Guidelines for Disposal of Dredged of Fill Material (33 U.S.C. § 1344) (40 CFR Part 230) (33 CFR 320-330) | No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the discharge which would have a less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences, or violate specific effluent limitations. Appropriate and practicable steps must be taken which will minimize the potential adverse impacts of the discharge of the dredged material on the aquatic ecosystem. | Inspect Middle Marsh and Adjacent Wetland for evidence of erosion or unauthorized filling. |
| Statement of Procedures on Floodplain Management and Wetlands Protection (40 CFR 6, App. A) | Federal agencies shall avoid, wherever possible, the long and short term impacts associated with the destruction of wetlands and the occupancy and modifications of floodplains and wetlands development wherever there is a practicable alternative in accordance with Executive Orders 11990 and 11988. The agency shall promote the preservation and restoration of floodplains so that their natural and beneficial values can be realized. Any plans for actions in wetlands or floodplains must be submitted for public review. | Inspect OU2 area for evidence of waterway obstruction, erosion, unauthorized filling. Monitor wetland restoration and take appropriate corrective actions if damage is encountered. |
| Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.) | Under 662, any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services, to develop measures to prevent, mitigate, or compensate for losses to fish and wildlife. This requirement is addressed under CWA Section 404 requirements. | No long-term O&M activity is associated with this ARAR. |
| RCRA Location Standards (40 CFR 264.18(b)) | This regulation outlines the requirements for constructing an RCRA facility on a 100-year floodplain. Specifically, a RCRA facility that is located on a 100-year floodplain must be designated, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless waste may be removed safely before floodwater can reach the facility or no adverse effects on human health and the environment would result if washout occurred. | No long-term O&M activity is associated with this ARAR. |

**TABLE 3-1**
**ARARs REVIEW DURING OPERATION & MAINTENANCE**

| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| Massachusetts Hazardous Waste Facility Siting Regulations (990 CMR 1.00) | These regulations outline the criteria for the construction, operation, and maintenance of a new facility or increase in an existing facility for the storage, treatment, or disposal of hazardous waste. As part of these requirements, a facility may not be located within a wetland or bordering a vegetated wetland, or within a 100-year floodplain, unless approved by the state. | No long-term O&M activity is associated with this ARAR. |
| Massachusetts Wetlands Protection Act (M.G.L. 131, § 40) (310 CMR 10.00) | These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting of inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Each remedial alternative will be evaluated for its ability to attain regulatory performance standards, including mitigation of impacted wetlands. | Monitor wetland restoration in accordance with Wetlands Restoration Plan (Appendix H to the approved 30% RD) and O&M Plan and take appropriate corrective actions if damage is encountered. |
| Massachusetts Endangered Wildlife and Wild Plants Regulations (321 CMR 8.00) | These regulations established Massachusetts' list of threatened and endangered species and species of special concern. The habitat of any species listed under this requirement is protected by the regulations promulgated under the MA Wetlands Protection Act. | Long-term monitoring for this ARAR is included in the monitoring procedures of the WRP and Operations and Maintenance Plan. |
| Massachusetts Wetlands Protection Program Policy 90-2; Standards and Procedures for Determining Adverse Impacts to Rare Species | This policy clarifies the rules regarding rare species habitat contained at 310 CMR 10.59. | Long-term monitoring for this ARAR is included in the monitoring procedures of the WRP and Operations and Maintenance Plan. |

**TABLE 3-1**
**ARARs REVIEW DURING OPERATION & MAINTENANCE**

| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| National Pollution Discharge Elimination System (NPDES) Clean Water Act (CWA) (40 CFR 122.125) (40 CFR 125) | Regulates the discharge of water into public surface waters. Among other things, major requirements are:<br><br>• Use of best available technology (BAT) economically achievable is required to control toxic and non-conventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.<br><br>• Applicable Federally approved State water quality standards must be complied with. These standards may be in addition to or more stringent than other Federal standards under the CWA. | Discharge is only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Toxic Pollutant Effluent Standards (40 CFR 129) | Regulates the discharge of the following pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, and PCBs. | Discharge is only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Massachusetts Surface Water Quality Standards (314 CMR 3.00 and 4.00) | These standards designated the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained and protected. Minimum water quality criteria required to sustain the designated uses are established. Federal AWQC are to be considered in determining effluent discharge limits. Where recommended limits are not available, site-specific limits shall be developed. Any on-site water treatment and discharge is subject to these requirements. | Discharge is only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Massachusetts Certification for Dredging, Dredged Material Disposal, and Filling In Waters (314 CMR 9.00) | The substantive portions of these regulations establish criteria and standards for the dredging, handling and disposal of fill material and dredged material. | Monitoring of surface water and sediment will be performed in accordance with the O&M Plan to verify continued compliance. |

**TABLE 3-1**
**ARARs REVIEW DURING OPERATION & MAINTENANCE**

| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| TSCA, Subpart D, Storage and Disposal (40 CFR 761.60, 761.65, 761.79) | All dredged materials that contain PCBs at concentrations of 50 ppm or greater shall be disposed of in an incinerator or in a chemical waste landfill or, upon application, using a disposal method to be approved by the EPA Region in which the PCBs are located. On-site storage facilities for PCBs shall meet, at a minimum, the following criteria:<br>• Adequate roof and walls to prevent rain<br>• Adequate floor with continuous curbing<br>• No openings that would permit liquids to flow from curbed area<br>• Not located at a site that is below the 100-year flood water elevation | No long-term O&M activity is associated with this ARAR. |
| Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00) | Water treatment units which are exempted from M.G.L.c.21C and which treat, store, or dispose of hazardous wastes generated at the same site are regulated to ensure that such activities are conducted in a manner which protects public health and safety and the environment. | Discharge is only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Massachusetts Hazardous Waste Regulations (310 CMR 30.000) | Regulate the generation, storage, collection, transport, treatment, disposal, use, reuse, and recycling of hazardous waste in Massachusetts. The regulations provide procedural standards for the following: generators (310 CMR 30.300), general management standards for all facilities (301 CMR 30.510), contingency plan, emergency procedures, preparedness, and prevention (310 CMR 30.520), manifest system (310 CMR 30.530), closure (310 CMR 30.580), ground water protection (310 CMR 30.660), use and management of containers (310 CMR 30.680), land disposal restrictions (310 CMR 30.760). | No long-term O&M activity is associated with this ARAR for OU2. |

**TABLE 3-1**
**ARARs REVIEW DURING OPERATION & MAINTENANCE**

| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| Interim Sediment Quality Criteria | These criteria were developed by U.E. EPA for certain hydrophobic organic compounds, including PCBs, to protect benthic organisms. The criteria for PCBs is 19.5 $\mu$g PCB/g organic carbon. | Monitoring of sediment/soil will be performed in accordance with the O&M Plan to verify continued compliance. |
| Massachusetts Allowable Ambient Air Limits - Annual (AALs) and 24-hour (TELs) | These guidances are to be considered in evaluating whether a condition of air pollution exists. The TEL for PCB is 0.003 $\mu g/m^3$ and the AAL is 0.005 $\mu g/m^3$. | Emissions anticipated only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Guidance on Remedial Actions for Superfund Sites with PCB Contamination | Describes various scenarios and considerations pertinent to determining the appropriate level of PCBs that can be left in each contaminated media to achieve protection of human health and the environment. | Monitoring of sediment/soil will be performed in accordance with the O&M Plan to verify continued compliance. |
| EPA Interim Policy for Planning and Implementing CERCLA Response Actions. Proposed Rule (50 FR 45933) (November 5, 1985) | Discusses the need to consider treatment, recycling, and reuse before offsite land disposal is used. Prohibits use of an RCRA facility for offsite management of Superfund hazardous substances if it has significant RCRA violations. | No long-term O&M activity is associated with this ARAR. |
| RCRA, Land Disposal Regulations (40 CFR 268, Subpart C) | Prohibits the disposal of RCRA hazardous waste in the land unless treatment standards are met or a treatability variance is obtained. | No long-term O&M activity is associated with this ARAR. |
| Clean Air Act (CAA) National Ambient Air Quality Standards (NAAQS) (40 CFR 50.6) | The maximum primary and secondary 24-hr. concentration for particulate emissions from site excavation activities must be maintained below 150 micrograms per cubic meter ($mg/m^3$), 24-hour average for particulates having a mean diameter of 10 micrometers or less. The annual standard is 50 $mg/m^3$, annual arithmetic mean. | Emissions anticipated only during remedial construction. No long-term O&M activity is associated with this ARAR. |
| Massachusetts Ambient Air Quality Standards and Massachusetts Air Pollution Control Regulations (310 CMR 7.00) (310 CMR 6.00, 7.00 and 8.00) | The applicable portions of these regulations prohibit burning or emissions of dust which causes or contributes to a condition of air pollution. | Emissions anticipated only during remedial construction. No long-term O&M activity is associated with this ARAR. |

**TABLE 3-1**
**ARARs REVIEW DURING OPERATION & MAINTENANCE**

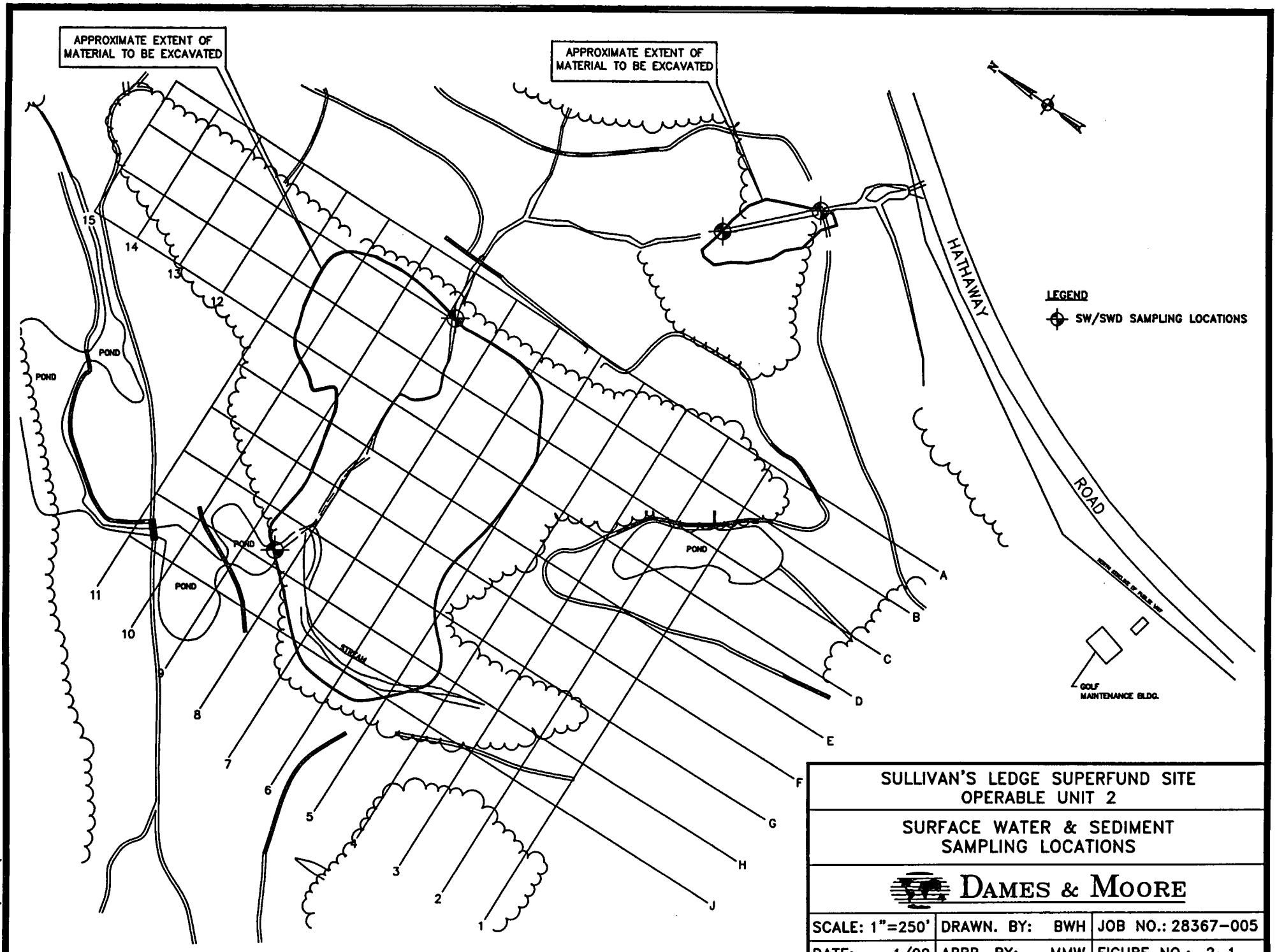
| Requirement | Requirement Synopsis (From ROD) | Long-Term Monitoring for Compliance |
|---|---|---|
| Federal Noise Control Act (40 CFR 204, 205, 211) | Regulates construction and transportation equipment noise, process equipment & noise levels, and noise levels at the property boundaries of the project. | No long-term O&M activity is associated with this ARAR. |
| Toxic Substance Control Act (TSCA), Subpart G, PCB Spill Clean-up Policy (40 CFR § 761.120-135) | Sets cleanup levels for PCB spills of 50 ppm or greater at 10 ppm for nonrestricted access areas, and 25 ppm for restricted access areas. | Monitoring of sediment/soil will be performed in accordance with the O&M Plan to verify continued compliance. |

## TABLE 4-1

## PRE-REMEDIATION WETLAND COVER COMPOSITION

| Wetland Type | Stratum | Pre-remediation areal coverage (range) % | Pre-remediation areal coverage mean % |
|---|---|---|---|
| Adjacent Wetland - Emergent | Herbaceous (Phragmites) | 107%[1] | 107% |
| Adjacent Wetland-Scrub-Shrub | Herbaceous | 66.5% | 66.5% |
| Adjacent Wetland-Scrub-Shrub | Shrub | 54.5% | 54.5% |
| Adjacent Wetland Forested | Trees | 70% | 70% |
| Adjacent Wetland Forested | Herbaceous | 27% | 27% |
| Adjacent Wetland Forested | Shrub | 41.5% | 55% |
| Middle Marsh-Emergent | Herbaceous (Phragmites) | 79.5% to 96% | 87% |
| Middle Marsh-Scrub-Shrub | Herbaceous | 22.5% to 92% | 53% |
| Middle Marsh-Scrub-Shrub | Shrub | 24% to 73.5% | 43% |
| Middle Marsh-Forested | Herbaceous | 28.5% to 85% | 50% |
| Middle Marsh-Forested | Shrub | 21% to 77% | 54% |
| Middle March-Forested | Trees | 38% to 94% | 70% |

1. Greater than 100% since more than one stratum considered.




SULLIVAN'S LEDGE SUPERFUND SITE
OPERABLE UNIT 2

SURFACE WATER & SEDIMENT
SAMPLING LOCATIONS

DAMES & MOORE

| | | |
|---|---|---|
| SCALE: 1"=250' | DRAWN. BY: BWH | JOB NO.: 28367-005 |
| DATE: 1/99 | APPR. BY: MMW | FIGURE NO.: 2-1 |

I:\28367\7240\F2-1

APPROXIMATE EXTENT OF MATERIAL TO BE EXCAVATED

APPROXIMATE EXTENT OF MATERIAL TO BE EXCAVATED

N

KEY

(2) PIEZOMETER LOCATIONS

(X) APPROXIMATE LOCATION OF MONITORING WELL 10A

(1) WELL POINT LOCATION NUMBER 1

▲ MIDDLE MARSH SEDIMENT SAMPLING LOCATION NUMBER 1

NOTE:
PIEZOMETER LOCATION 4 IN ADJACENT WETLAND COULD NOT BE INSTALLED

AT-3
AT-4
AT-2
AT-1
FENCE
HATHAWAY
ROAD
SOUTH EDGE OF PUBLIC WAY
GOLF MAINTENANCE BLDG.
POND
POND
POND
POND
MT-5
MT-4
MT-3
MT-2
MT-6
MT-1
PT-4
PT-5
PT-3
PT-6
PT-2
PT-1
SPRING

LEGEND

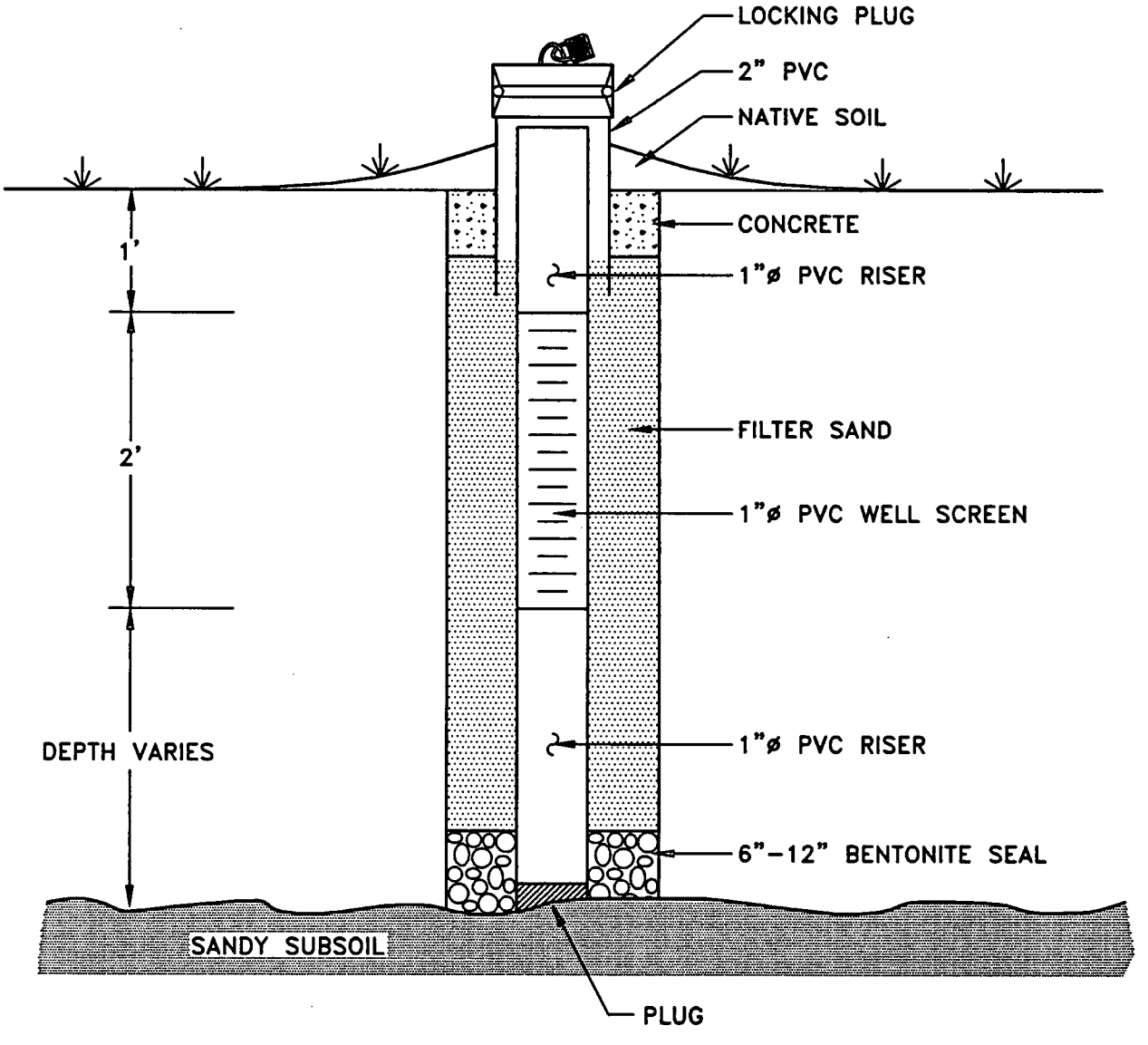
| | |
|---|---|
| PFO1 | PALUSTRINE, FORESTED, BROAD-LEAVED DECIDUOUS |
| PFO/SS1 | PALUSTRINE, FORESTED/SCRUB-SHRUB BROAD-LEAVED DECIDUOUS |
| PSS1 | PALUSTRINE, SCRUB-SHRUB, BROAD-LEAVED DECIDUOUS |
| PSS/EM1 | PALUSTRINE, SCRUB-SHRUB, BROAD-LEAVED DECIDUOUS/ EMERGENT, PERSISTENT |
| PEM1 | PALUSTRINE, EMERGENT, PERSISTENT |
| | UPLAND |
| PFO1 | PFO1 WITH AREAS OF PHRAGMITES. |

TITLE: PIEZOMETER LOCATIONS

PROJECT: SULLIVAN'S LEDGE SUPERFUND SITE - OPERABLE UNIT 2

DAMES & MOORE

| | | | |
|---|---|---|---|
| SCALE 1"=200' | DWN. BY DAM | JOB NO. 28367-005 | |
| DATE 12/18/95 | APPR. BY WSB | FIG. NO. 4-1 | |




## PIEZOMETER DETAIL

AVX CORPORATION
SULLIVAN'S LEDGE SUPERFUND SITE
OPERABLE UNIT 2

DAMES & MOORE

| | | | | | |
|---|---|---|---|---|---|
| SCALE | NTS | DRAWN BY | BWH | JOB NO. | 28367-005 |
| DATE | 1/99 | APPR. BY | GMG | FIG. NO. | 4-2 |

I:\28367\005\28367f2

# APPENDIX A

# INSPECTION CHECKLISTS

**SULLIVAN'S LEDGE SUPERFUND SITE**

# OPERABLE UNIT 2 SITE INSPECTION CHECKLIST

**FALL INSPECTION**
**GENERAL/SITE SECURITY/INSTITUTIONAL CONTROL**
**FIELD O&M TEAM LEADER:**
**OTHER FIELD TEAM MEMBER(S):**
**DATE & TIME OF INSPECTION:** **FROM** **A.M. TO** **P.M.**

| | CONDITION (Check) | | |
|---|---|---|---|
| **GENERAL INSPECTION** | **Acceptable** | **Not Acceptable** | **REMARKS** |
| Accumulation of litter or debris | | | |
| Evidence of erosion damage | | | |
| Health of upland vegetative cover | | | |
| Drainage obstruction | | | |
| Condition of roads and paths | | | |
| Other observations | | | |

| | CONDITION (Check) | | |
|---|---|---|---|
| **SITE SECURITY** | **Acceptable** | **Not Acceptable** | **REMARKS** |
| Fence fabric integrity | | | |
| Fence posts straight | | | |
| Fence rails | | | |
| Condition of gates | | | |
| Locks secure and functioning | | | |
| Warning signs every 100' and secure | | | |

| INSTITUTIONAL CONTROLS COMPLIANCE | CONDITION (Check) Present | Not Present | REMARKS |
|---|---|---|---|
| Site development or use other than for golf | | | |
| New groundwater wells | | | |
| Evidence of intrusive earthwork. | | | |
| Evidence of soils being removed from area | | | |
| Evidence of tampering with existing site feature (sells, survey markers, etc.) | | | |
| Any other observations | | | |

Field Inspection Certified Complete By:

Field Team Leader

Date

**SULLIVAN'S LEDGE SUPERFUND SITE**

# OPERABLE UNIT 2 SITE INSPECTION CHECKLIST

**WINTER INSPECTION**
**GENERAL/SITE SECURITY**
**FIELD O&M TEAM LEADER:**
**OTHER FIELD TEAM MEMBER(S):**
**DATE & TIME OF INSPECTION:** **FROM** **A.M. TO** **P.M.**

| GENERAL INSPECTION | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Accumulation of litter or debris | | | |
| Evidence of erosion damage | | | |
| Health of upland vegetative cover | | | |
| Drainage obstruction | | | |
| Condition of roads and paths | | | |
| Other observations | | | |

| SITE SECURITY | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Fence fabric integrity | | | |
| Fence posts straight | | | |
| Fence rails | | | |
| Condition of gates | | | |
| Locks secure and functioning | | | |
| Warning signs every 100' and secure | | | |

Field Inspection Certified Complete By:

_____ _____

Field Team Leader Date

**SULLIVAN'S LEDGE SUPERFUND SITE**

# OPERABLE UNIT 2 SITE INSPECTION CHECKLIST

**SPRING INSPECTION**
**GENERAL/SITE SECURITY/ENVIRONMENTAL MONITORING/WETLAND EVALUATION**
**FIELD O&M TEAM LEADER:**
**OTHER FIELD TEAM MEMBER(S):**
**DATE & TIME OF INSPECTION:** **FROM** **A.M. TO** **P.M.**

| GENERAL INSPECTION | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Accumulation of litter or debris | | | |
| Evidence of erosion damage | | | |
| Health of upland vegetative cover | | | |
| Drainage obstruction | | | |
| Condition of roads and paths | | | |
| Other observations | | | |

| SITE SECURITY | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Fence fabric integrity | | | |
| Fence posts straight | | | |
| Fence rails | | | |
| Condition of gates | | | |
| Locks secure and functioning | | | |
| Warning signs every 100' and secure | | | |

## WETLAND EVALUATION

| MYSTIC VALLEY AMPHIPOD (MVA) | Completed | Not Completed | REMARKS |
|---|---|---|---|
| Collection of MVA samples | | | |
| Identification and enumeration of MVA | | | |
| Observations of MVA habitat characteristics | | | |
| Preparation of MVA data report | | | |

| Wetlands Hydrology Monitoring | Completed | Not Completed | REMARKS |
|---|---|---|---|
| Measuring of groundwater levels - (1) | | | |
| Measuring of groundwater levels - (2) | | | |

Field Inspection Certified Complete By:

_____ _____

Field Team Leader Date

**SULLIVAN'S LEDGE SUPERFUND SITE**

# OPERABLE UNIT 2 SITE INSPECTION CHECKLIST

**SUMMER INSPECTION**
**GENERAL/SITE SECURITY/ENVIRONMENTAL MONITORING/WETLAND EVALUATION**
**FIELD O&M TEAM LEADER:**
**OTHER FIELD TEAM MEMBER(S):**
**DATE & TIME OF INSPECTION:** **FROM A.M. TO P.M.**

| GENERAL INSPECTION | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Accumulation of litter or debris | | | |
| Evidence of erosion damage | | | |
| Health of upland vegetative cover | | | |
| Drainage obstruction | | | |
| Condition of roads and paths | | | |
| Other observations | | | |

| SITE SECURITY | CONDITION (Check) Acceptable | Not Acceptable | REMARKS |
|---|---|---|---|
| Fence fabric integrity | | | |
| Fence posts straight | | | |
| Fence rails | | | |
| Condition of gates | | | |
| Locks secure and functioning | | | |
| Warning signs every 100' and secure | | | |

| ENVIRONMENTAL MONITORING | Completed | Not Completed | REMARKS |
|---|---|---|---|
| Field marking of sample locations | | | |
| Collection of downstream Middle Marsh surface water sample | | | |
| Collection of downstream Middle Marsh sediment sample | | | |
| Collection of upstream Middle Marsh surface water sample | | | |
| Collection of upstream Middle Marsh sediment sample | | | |
| Collection of Adjacent Wetland surface water sample | | | |
| Collection of Adjacent Wetland sediment sample | | | |
| Collection of two wetland soil samples from Adjacent Wetland | | | |
| Collection of four wetland soil samples from Middle Marsh | | | |
| Sample preservation, packing and shipment | | | |

| WETLAND EVALUATION | Completed | Not Completed | REMARKS |
|---|---|---|---|
| Sample representative wetlands vegetation quadrats | | | |
| Record coverage and condition of hummocks | | | |
| Record soil profiles (every 5 years) | | | |
| Record plant survival rates and tree growth | | | |
| Photographic documentation | | | |
| Record vegetation diversity and areal coverage | | | |
| Prepare annual data report | | | |

| Wetlands Hydrology Monitoring | Completed | Not Completed | REMARKS |
|---|---|---|---|
| Measure groundwater levels - (3) | | | |
| Measure groundwater levels - (4) | | | |

Field Inspection Certified Complete By:

_____ _____

Field Team Leader Date

**SULLIVAN'S LEDGE SUPERFUND SITE**

# OPERABLE UNIT 2 SITE MAINTENANCE SCHEDULE

**GENERAL/SITE SECURITY/WETLAND**
**FIELD O&M TEAM LEADER:**
**OTHER FIELD TEAM MEMBER(S):**
**DATE & TIME OF MAINTENANCE ACTIVITY; FROM A.M. TO P.M.**

| MAINTENANCE PERFORMED (check) | GENERAL MAINTENANCE ITEM | REMARKS |
|---|---|---|
| | Removal of litter or debris | |
| _____<br>_____<br>_____ | Repair of erosion damage:<br>• Filling<br>• Grading<br>• Other (describe) | |
| _____<br>_____<br>_____<br>_____<br>_____<br>_____ | Care of upland vegetative cover:<br>• Seeding<br>• Fertilizing<br>• Topsoil replacement<br>• Removal of undesired vegetation<br>• Grass cutting<br>• Other (describe) | |
| | Removal of drainage obstruction | |
| _____<br>_____<br>_____<br>_____ | Repair of roads and paths<br>• Filling<br>• Grading<br>• Paving (asphalt or stone)<br>• Other (describe) | |
| | Other maintenance (describe) | |

| MAINTENANCE PERFORMED (check) | SITE SECURITY MAINTENANCE ITEM | REMARKS |
|---|---|---|
| | Repair or replace fence fabric | |
| | Repair or replace fence posts | |
| | Repair or replace Fence rails | |
| | Repair or replace gates | |
| | Repair or replace locks | |
| | Repair or replace warning signs | |
| | Other maintenance (describe) | |

| MAINTENANCE PERFORMED (check) | WETLAND MAINTENANCE ITEM | REMARKS |
|---|---|---|
| | Evaluate conditions of tree species (height, DBH, canopy) | |
| | Evaluate general growth and health of restored wetland plants - replace plants if required | |
| | Evaluate condition of hummocks | |
| | Assess invasive species, corrective action if required | |
| | Evaluate erosion in restored wetlands, replace top soil, if required | |
| | Evaluate whether major impacts to restored wetlands, report to USEPA if required | |
| | Evaluate whether condition is too dry to support wetland plants. Irrigate if necessary. | |

Field Inspection Certified Complete By:

Field Team Leader _____ Date _____

# APPENDIX B

# A GUIDE TO INVASIVE PLANTS IN MASSACHUSETTS

United States. Dover Publications, Inc. New York, NY.

Compendium on Exotic Species. 1992. Natural Areas Association, 320 S. Third St., Rockford, IL 61104. (43 short articles about invasive plant species and their control).

McKnight, Bill N., 1993. Biological Pollution: The control and impact of invasive species. Indiana Academy of Science, Indianapolis.

Randall, J.M. & J. Marinelli (Eds.). 1996. Invasive Plants: Weeds of the Global Garden. Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, NY 11225 (Good color photos and descriptions covering invasive plants nationwide).

Weatherbee, P. B. 1994. The most unwanted plants. Massachusetts Wildlife. Division of Fisheries and Wildlife, Westborough MA 01581.

White, D.J., E.Haber & C.Keddy.I 1993. Invasive Plants of Natural Habitats in Canada. Rept. prepared by Canad. Mus. of Nature for Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 121 pp.

A companion guide to this publication – *A Guide to Invasive Non-native Aquatic Plants in Massachusetts* by C. Barre Hellquist – is available from the Mass. Department of Environmental Management, Lakes & Ponds Program, 100 Cambridge St., Boston, MA 02202

## About the Authors:

**Pamela B. Weatherbee** is the author of *The Flora of Berkshire County* and a member of the Massachusetts Non-Game Advisory Committee.

**Paul Somers** is the State Botanist with the Massachusetts Division of Fisheries & Wildlife's Natural Heritage & Endangered Species Program.

**Tim Simmons** is the Restoration Ecologist with the Massachusetts Department of Fisheries, Wildlife & Environmental Law Enforcement's Biodiversity Initiative.

**MassWildlife**

This publication was supported by funds authorized in the 1996 Open Space Bond Bill. The Ecological Restoration Program studies natural systems and then develops and implements strategies and techniques to restore ecosystems and natural systems significant to the state's biodiversity. The Biodiversity Initiative's Ecological Restoration Program is a new program within the Massachusetts Department of Fisheries, Wildlife & Environmental Law Enforcement, and the Massachusetts Division of Fisheries & Wildlife.



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# INVASIVE PLANTS in Massachusetts

Photo by Bill Byr

by

Pamela B. Weatherbee, Paul Somers and Tim Simmons

## The Massachusetts Biodiversity Initiative

*Massachusetts*
**Division of Fisheries & Wildlife**

## a Serious Threat?

Plants introduced from somewhere else leave behind the diseases and herbivores that kept them under control in their native habitats. This provides them with an advantage that allows some of them to crowd out native species.

Some non-native plants were introduced deliberately for their vigorous, growth potential: exceptional for erosion control, but a big problem for slower growing native plants. A few were selectively bred to produce abundant fruits and seeds attractive to birds and other wildlife — and thus are readily spread by these animals into many habitats. Others arrived unintentionally in a variety of ways and their spread has been accelerated by human activities and pathways of transportation. Most of these plants thrive in disturbed areas: roadsides, abandoned fields, right-of-way corridors and ditches.

These invasive, typically non-native species (also called "exotics" or "alien weeds") often occur in huge patches — one species taking the place of a great variety of native plants — thus reducing the biodiversity of natural areas.

**Why do we need biodiversity?** Our plants and animals have evolved together for thousands of years, developing into a closely interwoven web of life, with many animals and plants dependent on specific species for their survival. Invasive plant populations change the characteristics of these complex webs and can lead to the elimination of many plants and animals. For example, some butterflies require a specific food plant, and many plants require specific pollinators. If invasive plants crowd out the species the butterfly needs, or the ones the special pollinators need, whole sections of the web can collapse, diminishing the wildlife community. Do we really want a world of just starlings and dandelions?

Plants have been moving around the landscape and evolving since life began. However, these current invasions of aggressively spreading plants are not natural range extensions (which would include natural control agents and give native species time to develop competitive strategies). They are moving so fast and are so overwhelming that many native species simply cannot contend with them. All too frequently, natural habitats are degraded by multiple invasive species.

Many of these "bad plants" are still being planted because they seem to fill a particular need for fast-growing erosion control, visual screening, windbreaks, wildlife foods, or even as garden plants. Native plants can and should be used to fill these needs. Some are available in nurseries and seed catalogs, and others are being studied for their potential uses.

**Most introduced species, such as garden, meadow, and agricultural species, are NOT harmful.** Only a few are troublemakers. If we know the characteristics of a plant we may be able to predict how it will behave; whether it will spread like wildfire or stay where it is planted. Responsible introduction of new species or varieties should involve careful research and testing before release.

### A Typical Harmful Invasive Plant

1. Grows and matures rapidly
2. Spreads quickly
3. Can flower and/or set seed all season
4. Has no known diseases or pests to control it
5. Thrives in many habitats
6. Is difficult to remove or control

## Individuals and Organizations Do?

First, be aware of the value of our native habitats to wildlife and the dangers posed by invasive non-natives.

Join local groups that are introducing people to the enjoyment of local native habitats and wildlife communities.

Don't plant invasive species or spread them inadvertently (for instance, collecting oriental bittersweet for fall or winter decorations, and later discarding the stems, fruit and seeds outside).

Learn to identify the most invasive species. The ones featured on the following pages are among the worst currently found in Massachusetts.

If you notice new or small populations of invasive species on public land or nature reserves, notify the managers. Caught in time, the weeds may be controlled; otherwise it will involve expensive, arduous labor to remove them. Land managers are in a good position to take action against new invaders.

If you are a landowner or land-manager, be vigilant for the appearance of invasive species on your property. Learn how to eradicate or control them (this booklet should help), and take steps to do so before they become a serious problem.

Don't disturb soil or vegetation in natural areas unnecessarily. Undisturbed natural areas are resistant to invasion.

Encourage the planting of native species in municipal and town gardens, memorial sites, parks, traffic islands, etc. Ask your nursery to stock more native species; point out any plants for sale at your nursery that are known to be harmful invasives.

Contact the Division of Fisheries and Wildlife, The Wildflower Society, your local garden club and other environmental or agricultural organizations for information on what to plant. Join conservation organizations that are protecting natural habitats, plants and wildlife.

## Control of Invasive Plant Species

An exotic plant invasion can move through an area with the speed of an epidemic. Like a disease, eliminating it right away, or better yet, preventing its introduction in the first place, is always the best medicine. Pulling or killing a few stems, saplings or seedlings when they first appear may prevent an insurmountable problem later. **(Make sure you've correctly identified the plant first; don't destroy native species by mistake!)**

Attacking the problem by hand with the aid of a few gardening tools is least destructive to the habitat; plants can be pulled, mowed, or cut. Always keep in mind that each species will respond differently to each control method. Some sprout prolifically when cut, for instance, and may require multiple cuttings for several years before their roots will finally die. Find out what works for the species you are dealing with, and what methods may make matters worse.

Treating invasive plants with herbicides is often an effective control method, but it should be used cautiously and with discretion. Other alternatives should always be considered first. Be sure to read and follow instructions on herbicides sold over the counter at stores and garden centers. Consider seeking professional advice from licensed applicators or the state Pesticide Bureau in the Massachusetts Department of Food & Agriculture. When considering application in or near wetland areas, town conservation commissions or administrators must be consulted.

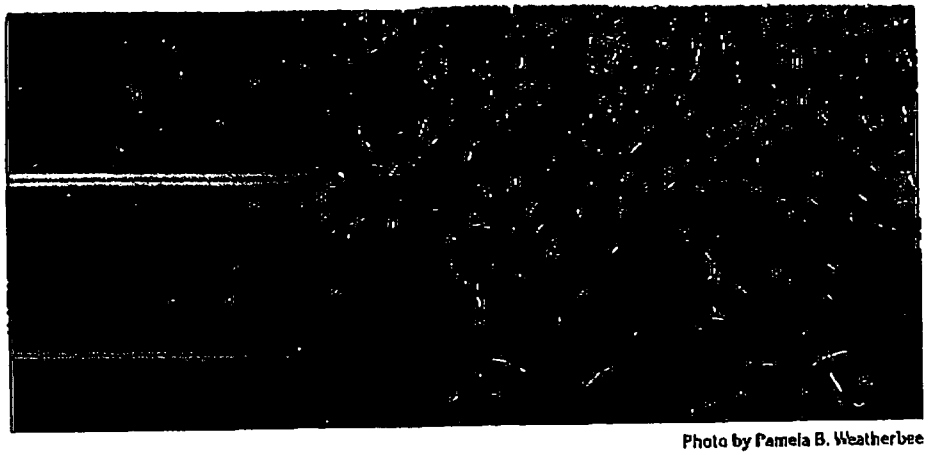


Photo by Pamela B. Weatherbee

# Black Swallow-wort

## *Cynanchum louiseae*

A charming little vine related to the milkweed, this aggressive plant can spread explosively, covering open areas, edges and hedgerows, and eliminating all other vegetation. Small maroon flowers soon produce wind-borne seeds that drift everywhere, making this species hard to control. A closely related species with paler flowers known as "dog-strangling vine," *Cynanchum rossicum*, behaves similarly and is now considered a weed in parts of Connecticut.

Artwork by Anne Rogelberg and Laura Vogel, courtesy The New York Botanical Garden

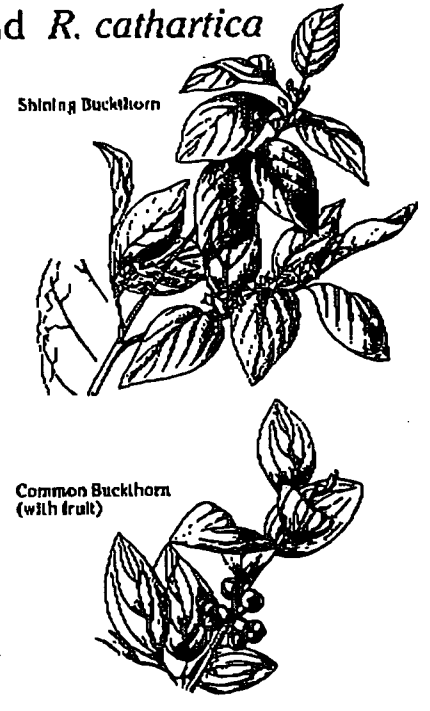
Shining Buckthorn

Photo by Frank Bramley, courtesy New England Wildflower Society

# Shining and Common Buckthorn

## *Rhamnus frangula* and *R. cathartica*

Shining Buckthorn is the more abundant of these two shrubs in Massachusetts. Although sometimes found in uplands, it typically invades marshes, swamps, bogs, wet meadows and the edges of beaver ponds, crowding out a variety of native species. Common Buckthorn is typically found on drier sites. Both shrubs are tolerant of dense shade. They flower and fruit all season and spread rapidly because birds eat their berries and thus spread seeds. Removal is difficult because stems resprout after cutting. If stems are cut and herbicide applied to their stump tops in winter, mortality is high. Young plants can be pulled by hand and older ones pulled mechanically. Because of regeneration from remaining root and stem, as well as dormant seed, follow-up work will be necessary in subsequent years.




Artwork by Anne Rogelberg, courtesy The New York Botanical Garden

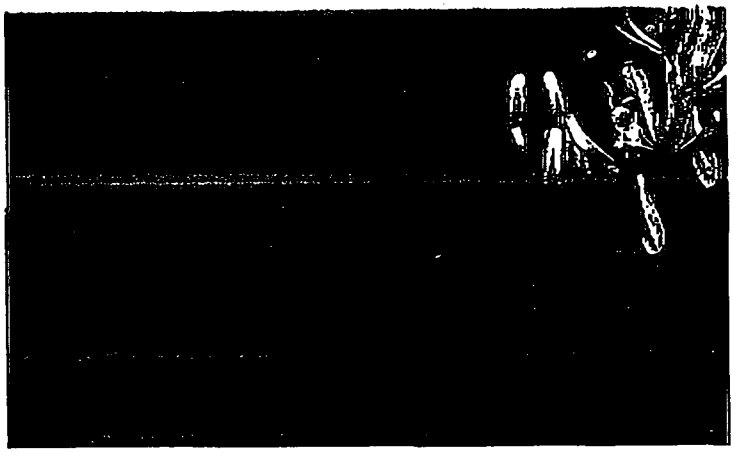
Photo by Paul Somers

# Japanese Honeysuckle

*Lonicera japonica*

This climbing honeysuckle displays large white or cream-colored, fragrant flowers that occur in pairs. Each flower pair later forms two black, fleshy berries. The vine chokes supporting trees and shrubs by twining tightly around and over them, forming dense patches. Already a major pest from Connecticut southward, where it invades successional forest and fencerows, it is a localized problem in parts of Massachusetts. Early detection and control is imperative; once established, it is very difficult to remove.

Artwork by Eduardo Salgado, courtesy The New York Botanical Garden

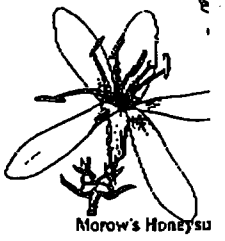


Morrow's Honeysuckle

# Morrow's Honeysuckl and other shrub honeysu

*Lonicera morrowii, L. tatarica, L. maackii*

The red berries of the shrubby honeysuckles are spre and the resulting shrubs quickly form impenetrable thi ing other vegetation in young forests and on floodplains and Amur (*L. maackii*) have white flowers fading to yell and its hybrid with Morrow's, *L. xbella*, are pink. Morro pervasive in Massachusetts and can be distinguished from Tatarian honeysuckle by its hairy leaves and shreddy bark. It appears that Tatarian honeysuckle is not as invasive. Amur honeysuckle (*L. maackii*) is not yet common in Massachusetts, but is the predominant weedy honeysuckle in some midwestern states. Young shrubs can be pulled by hand, but mechanical means are necessary for extracting established older ones. Before initiating control measures, be certain that the plants in question have been identified correctly: there are two native species of honeysuckle that belong in the New England plant community.



Morow's Honeysu

Artwork by Eduardo Salgado, courtesy The New York Botanic

Photo by Paul Somers

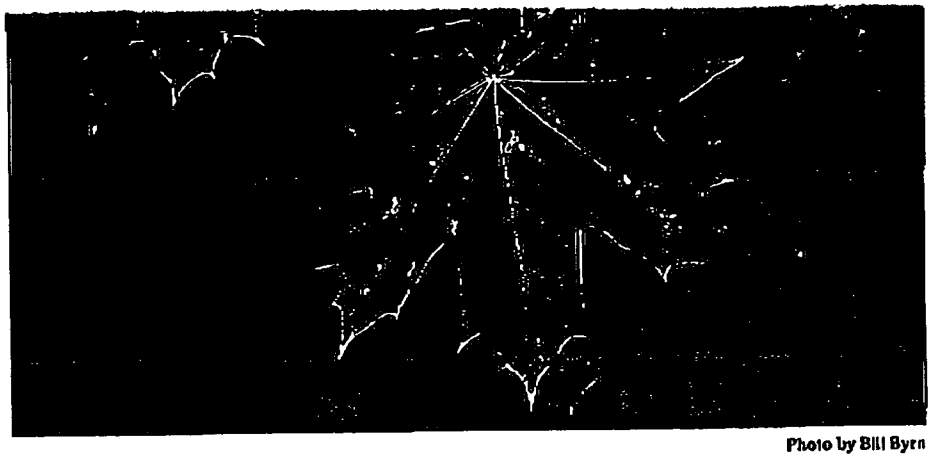


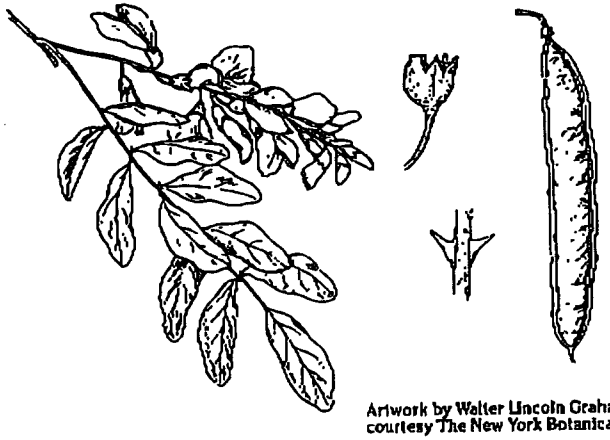
Photo by Bill Byrn

Trees

# Black Locust

*Robinia pseudoacacia*

Not a native of the New England region, Black Locust has been extensively planted for wood, fence posts and landscaping in Massachusetts. It becomes a problem when large patches formed by root sprouts choke out other vegetation. It forms large colonies in grasslands and pine barrens in southeastern Massachusetts. Cutting, then herbiciding the freshly cut stumps, has proven to be an effective method of control.



Artwork by Walter Lincoln Graham, courtesy The New York Botanical Garden

# Norway Maple

*Acer platanoides*

Widely planted as an ornamental and street tree, this maple has seeded into roadsides, wetland edges and forests, and may outcompete our native Sugar Maple. Dense shade under its canopy reduces species of wildflowers and other tree seedlings. Easily overlooked by its similarity to Sugar Maple, identify it by its wide leaves with milky sap (tear a leaf or its stem and check the broken veins) and regular furrowed bark. Saplings can be pulled and large trees cut.

Artwork by Eduardo Salgado, courtesy The New York Botanical Garden

Photo by Frank Bramley, courtesy New England Wildflower Society

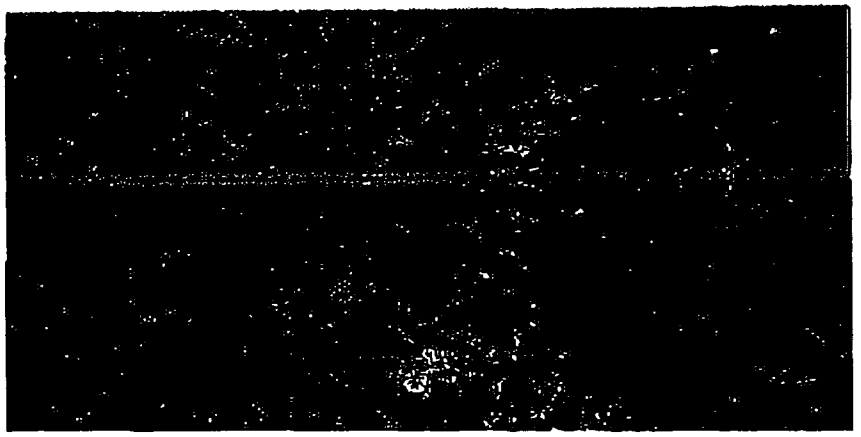


Photo by I

Shrubs and Vines

# Oriental Bittersweet

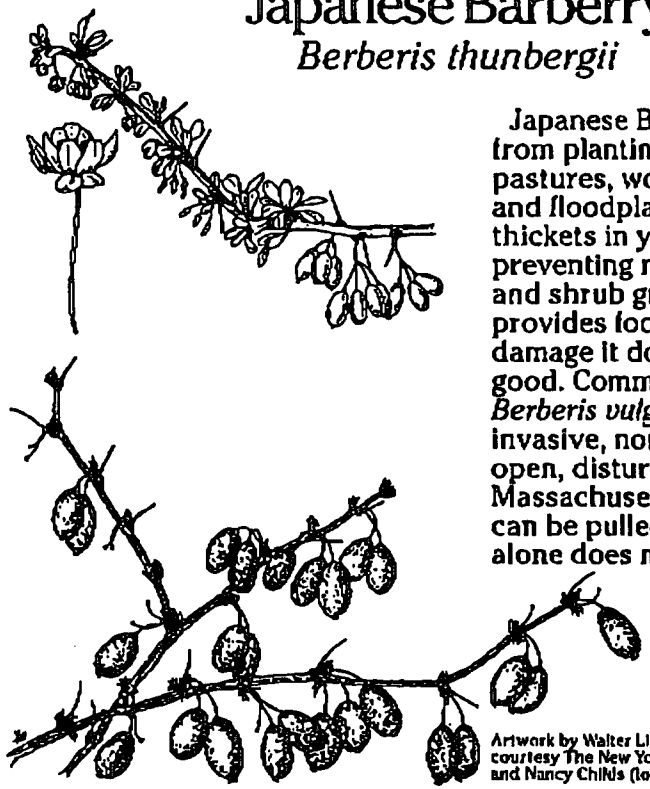
*Celastrus orbiculata*

A fast growing vine, Oriental Bittersweet can wind around young trees, choking them, or spread over vegetation, smothering it. Similar to the now-scarce native bittersweet, it differs by having flower clusters all along the stem. The vine interferes with forest regeneration, kills trees, covers fields and hedgerows, and displaces native plants. Once established, it is extremely difficult to eliminate, but mowing, cutting or hand-pulling of vines may help. Due to extensive below-ground "runners" (rhizomes) that sprout prolifically, herbicide treatments applied to cut stems at the time of the first killing frost are often necessary to achieve control.

Artwork by Eduardo Salgado, courtesy The New York Botanical Garden, and Nancy Childs (lower illustration)

# Japanese Barberry

*Berberis thunbergii*



Japanese Barberry has spr from plantings, taking over pastures, woodlands, ledges and floodplains. It forms thc thickets in young woodland: preventing native herbaceo and shrub growth. Although provides food for wildlife, th damage it does outweighs th good. Common Barberry, *Berberis vulgaris*, is also an invasive, non-native shrub i open, disturbed habitats acr Massachusetts. Young plant can be pulled easily; cutting alone does not work.

Artwork by Walter Lincoln Graham, courtesy The New York Botanical Garden, and Nancy Childs (lower illustration)

Photo by Bill Byrne

# Autumn Olive

*Elaeagnus umbellata*

Until quite recently, fast-growing Autumn Olive and Russian Olive (*Elaeagnus angustifolia*) were considered ideal for screening. They have been used in wildlife plantings for decades because of their abundant, fleshy red fruits. On the negative side however, these shrubs (Autumn Olive in particular) spread rapidly into old fields and natural grasslands, creating dense thickets that crowd out native vegetation. Autumn Olive's distinctive scaly, silvery leaves soon become green on the upper side, whereas those of Russian Olive remain silvery on both surfaces. Small fragrant flowers, silvery without and pale yellow within, produce reddish berries. These are avidly eaten by birds, which spread the seeds far and wide. Control of established colonies may require a combination of mechanical means and herbicide treatments.

Artwork by Laura Vogel,
courtesy The New York Botanical Garden



# Porcelain Berry

*Ampelopsis brevipedunculata*

Currently most abundant along the coast, this vigorous vine can cover the ground and overwhelm trees and shrubs, especially in disturbed areas, along shorelines and around forest edges. The leaves, often three-lobed, are similar to grape, a close relative. The distinctive, small, grape-like berries start off lilac in color, then mottle, maturing to a bright blue with a waxy sheen. Climbing by tendrils, this plant is difficult to eradicate, but pulling the vines from trees and then repeatedly cutting or mowing the remaining plants will help control it.

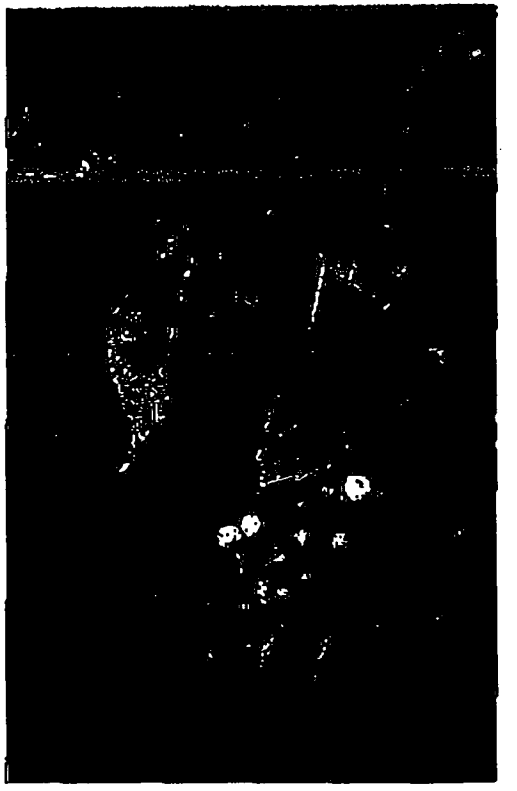
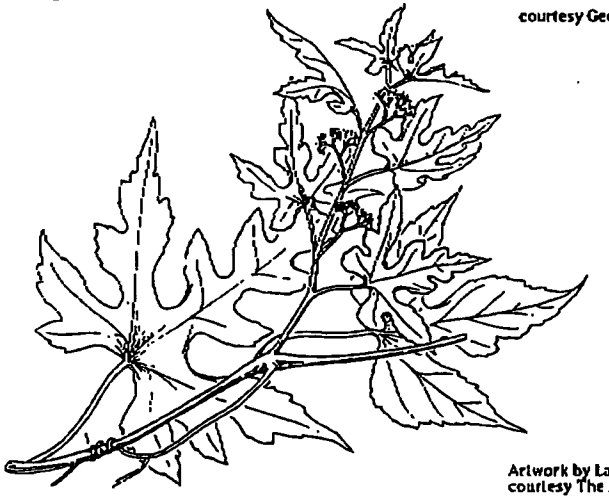


Photo by Leslie J. Mehrhoff
courtesy George Stafford Torrey Herbarium



Artwork by Laura Vogel,
courtesy The New York Botanical Garden

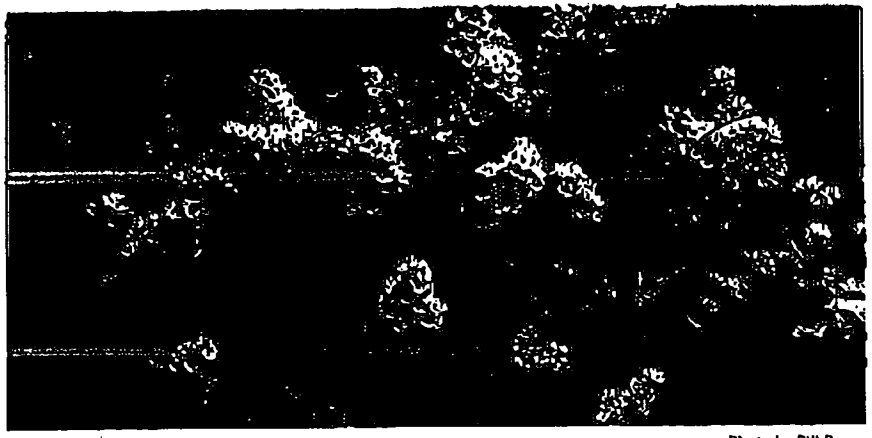


Photo by Bill Byrne

# Multiflora Rose

*Rosa multiflora*

Originally promoted as a "living fence," this aggressive shrub now creates a "living hell" of thorny thickets. Thriving in any habitat from pasture to forest, it can displace many native trees, shrubs and herbs, effectively thwarting their regeneration. Clusters of many white flowers produce tiny red fruits (hips) spread by birds. Hand-pulling works for small plants, but large ones will require other techniques such as repeated cutting or mowing during the growing season for a couple of years. Once established, mechanical pulling or an herbicide applied to cut stems late in the growing season or during the dormant season can be effective.

Artwork by Regina O. Hughes, courtesy Agricultural Research Service, U.S. Department of Agriculture



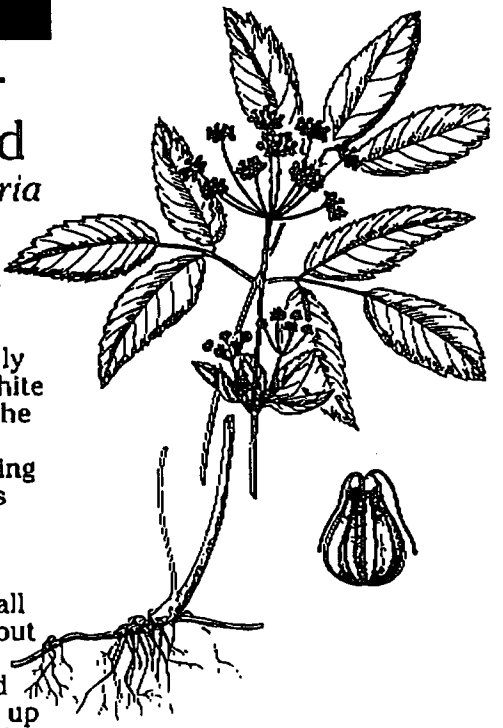
Photo by Paul Somi

**Herbaceous Annuals and Perennials**

# Goutweed or Bishop's Weed

*Aegopodium podagraria*

An escapee from gardens, where it was a handy ground cover, Bishop's Weed has invaded floodplains, forming dense mats. In the same family as Queen Anne's Lace, the white flower cluster is similar but the leaves, instead of being lacy, have toothed leaflets appearing in threes. Some garden forms have variegated leaves with broad white margins (as in photo). It spreads by underground rhizomes. Even a small piece left in the soil may sprout into a plant, making it very difficult to exterminate. Hand pulling or raking, with follow up monitoring and removal of all new plants, is necessary.



Artwork by Lucille E. Blum and Laura Vogel, courtesy The New York Botanical Garden

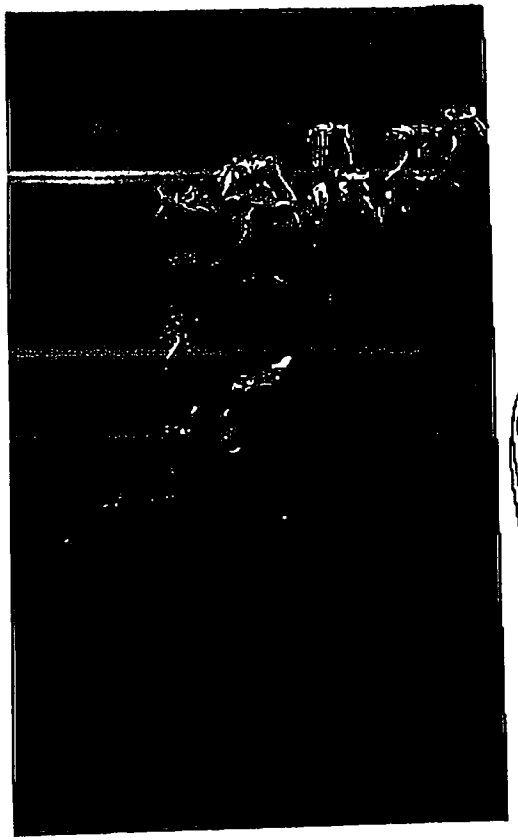


Photo by Pamela B. Weatherbee

# Yellow Iris

*Iris pseudacorus*

Beautiful but aggressive, Yellow Iris will spread rapidly on pond shores and in wetlands and can pre-empt sites where native wetland plants, including two native iris species, would grow. It has also invaded rocky coastal shoreline habitat in northeastern Massachusetts. Pulling or digging it out when first seen may be preferable to pursuing herbicide usage in wetland settings.

Artwork by Mary C. Easton, courtesy The New York Botanical Garden

# Japanese Knotweed or Japanese Bamboo

*Polygonum cuspidatum*

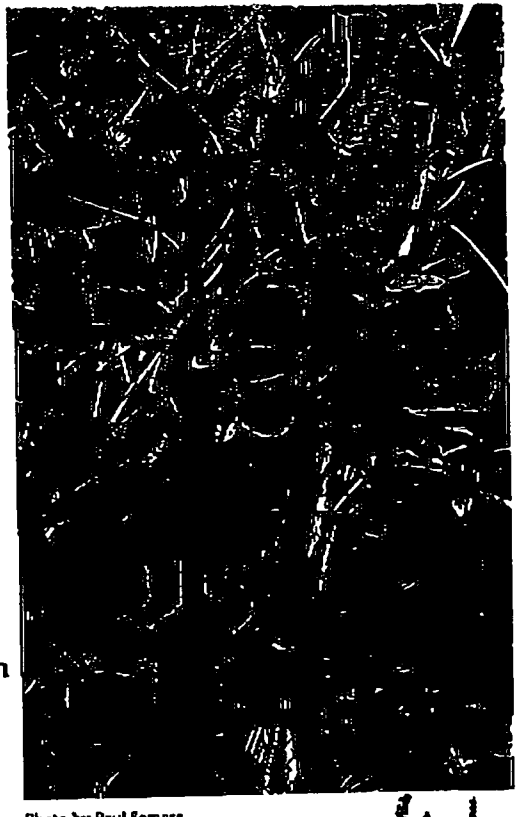
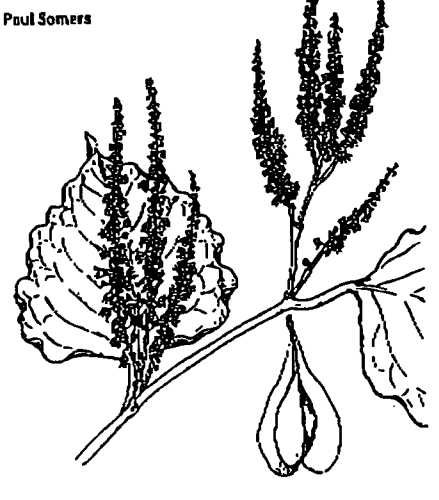


Photo by Paul Somers

Most harmful to natural habitats on riverbanks, gravel bars and floodplains, this plant spreads by rhizomes up to 60 feet long. Rhizome fragments frequently are the source of new downstream colonies, since even a small piece can generate a new plant. Its hollow bamboo-like stems form large patches that eliminate all other vegetation. Also, the large, loose inflorescense of whitish-green flowers produce abundant, shiny black, triangular seeds that disperse easily. A minimum of four cuttings during a growing season are required to eliminate the underground reserves of a colony. With small patches, removal by digging may be a practical and effective option.



Artwork by Walter Lincoln Graham, courtesy The New York Botanical Garden

Photo by Frank Bramley,
courtesy New England Wildflower Society

# Purple Loosestrife

*Lythrum salicaria*

Although a showy wetland plant that many find beautiful, Purple Loosestrife forms impenetrable mats where few other plant species can live. By reducing the variety or abundance of native plants in the marsh, the survival or success of many animals that have evolved to use these plants for cover, food and nesting areas are affected. Purple loosestrife should be removed immediately when first noticed because it is almost impossible to exterminate. Each plant produces up to 2 million seeds each year which remain viable for many years in wetland soils. Biological controls may be the only practical way to control most infestations. Two Eurasian leaf-eating beetles and a weevil have been released in many areas following tests at Cornell University to determine how they might behave in natural environments; initial results seem promising with much reduction of Purple Loosestrife.

Artwork by Lucille E. Blum,
courtesy The New York Botanical Garden

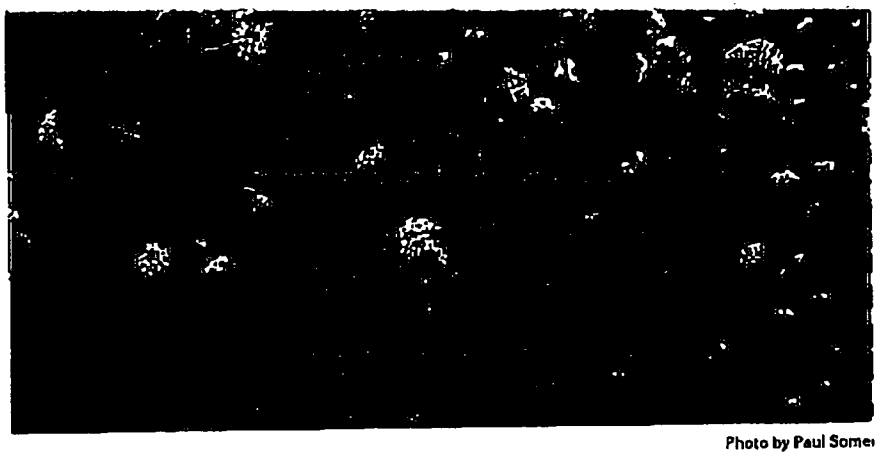
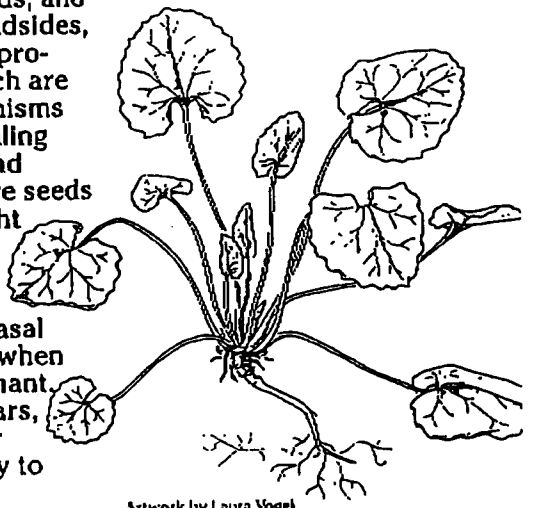


Photo by Paul Somers

# Garlic Mustard

*Alliaria petiolata*

Garlic Mustard, an herbaceous biennial herb native to Europe, has garlic-smelling, round, toothed leaves and small flowers with four white petals. It outcompetes many native wildflowers in floodplains and woodlands, and is a pestiferous weed in roadsides, hedgerows and gardens. It produces abundant seeds which are easily dispersed by mechanisms such as flooding. When dealing with small populations, hand pulling all individuals before seeds ripen for several years might work, but with larger ones it will be necessary to augment this with herbicides applied to overwintering basal rosettes during the winter when most other plants are dormant. Seed remains viable 2-5 years, so follow-up treatments for several years are necessary to accomplish control.



Artwork by Laura Vogel,
courtesy The New York Botanical Garden

Photo by Bill Byrne

# Phragmites or Common Reed

*Phragmites australis*

A 15 foot tall grass with plume-like seed heads, Common Reed spreads rapidly in wetlands by its extensive rhizomes. Originally a native species of brackish marshes in eastern Massachusetts, it now follows salt-laden highway margins and pipeline corridors, spreading into adjacent land. It chokes out all other vegetation and sharply reduces the value of wetlands habitat to most wildlife. Labor intensive cutting followed by the application of herbicide to stems is effective, but also quite costly. Hydrologic controls (e.g., flooding for four months during the growing season), dredging, and summer/fall burning are other techniques that have worked in particular situations. A combination of treatments is often a good approach.

Artwork by Mary C. Easton, courtesy The New York Botanical Garden



The following species are presently not common in Massachusetts and are not causing any immediate, serious problems in the state. However, based on past experience and their record in other states, they are regarded as likely future pests.

## Trees

### Princess Tree

*Paulownia tomentosa*

A fast growing tree with large broad leaves, it is more of a problem in the mid-South, where it outcompetes native trees. While only known from a few sites in Massachusetts, at present it is regarded as invasive in Connecticut. Its soft, white wood is prized in the Orient for use in traditional wedding boxes, so even in this country it brings a good price on the market. In the spring it has upright clusters of velvety, deep blue, fragrant flowers.

### Western Catalpa or Cigar Tree

*Catalpa speciosa*

### and Chinese or Yellow Catalpa

*Catalpa ovata*

Western Catalpa is a midwestern and southern U.S. native that has spread from plantings and is hardy in Massachusetts and tolerant of periodic flooding in the floodplain forests of our major rivers. It, along with its yellow-flowered relative, the Chinese Catalpa, which also is naturalizing into western Massachusetts habitats, pose new problems for natural lands managers. Both species resprout from cut stumps.

## Shrubs and Vines

### Hardy Kiwi

*Actinidia arguta*

An Asian relative of the edible kiwi of New Zealand, it and other Asian relatives are now being sold widely in temperate North America. Advertised as having fragrant flowers, edible fruit and strong-growing vines, it can behave like Oriental Bittersweet smothering other vegetation in forests and clearings. It can withstand temperatures down to -30° and appears to be hardy in the Berkshires where it is a weedy invader in natural settings.

### Winged Euonymus, Wahoo or Burning Bush

*Euonymus alata*

This shrub has been planted extensively for years because of its bright red fall foliage and fruit and corky winged branches. Now it is invading forests and pastures. Considered a frequent and abundant weed in Connecticut, where it replaces native understory shrubs, it occurs in natural habitats throughout Massachusetts. Berries are spread by birds, and there is an abundant seed source in ornamental plantings. Young plants can be hand-pulled, but with large patches, either mechanical pulling or cutting stems and applying herbicide may be more practical and effective.

"The plant that ate the South" has persisted where introduced at a few places in southeastern Massachusetts. Since it dies back each winter in this climate, it may be limited by lack of hardiness. Nevertheless, given its reputation in the south, it should be watched.

## Herbaceous Annuals and Perennials

### Mile-A-Minute Plant
*Polygonum perfoliatum*

Not in the state yet, but documented a year ago just south of the border in Connecticut. Given its name, it may be here already as you read this. A prickly vine with triangular leaves, it crawls or climbs with the aid of backward bending barbs along its weak branching stems. It smothers other vegetation and its seeds are spread by birds that eat its pea-sized, iridescent blue fruits.

### Japanese Stilt Grass
*Microstegium vimineum*

Spreading northward from the southeastern United States, this annual grass is now considered an invasive weed in Connecticut. It is very shade tolerant, growing in less than 5% light. Typically, it forms a loosely interwoven, 6-10 inch tall carpet of weak stems, spreading rapidly through river floodplains or recently disturbed areas such as logging roads. It spreads by seeds or plant fragments. A healthy plant can produce over a thousand seeds a year.

This tall, aggressive grass has the potential to be as destructive as Phragmites. At present it is limited to one wetland location in Essex County where it is excluding all other vegetation including Purple Loosestrife. Efforts to control it with cutting and herbicide treatments have yet to eradicate it at this site. There is always a danger that a few rhizomes could start a new colony, or that its seeds could land where it can get established.

### Ornamental Grasses such as Eulalia
*Miscanthus sinensis*
**and others**

Some species may pose a problem as they are being planted in ever increasing numbers without full testing for invasive qualities. Eulalia, for instance, is planted for its silvery inflorescense and variegated foliage, but has been observed spreading into native grassland habitat at a site on Cape Cod. Some bamboos are hardy and may spread aggressively through containers and walls. These may be difficult to eradicate once established.





The following is a list of non-native plants recorded in Massachusetts which possess strongly invasive characteristics. Those which are currently presentin the greatest threat to native plant communities are highlighted. Remember however, that some species which are not highlighted may eventually becom major problems, and that others may not become widespread problems.

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| **Amur honeysuckle** | ***Lonicera maackii*** |
| **Autumn olive** | ***Elaeagnus umbellata*** |
| **Barnyard grass** | ***Echinochloa crusgalli*** |
| **Black locust** | ***Robinia pseudoacacia*** |
| **Black swallow-wort** | ***Cynanchum louiseae*** |
| **Bittersweet nightshade** | ***Solanum dulcamara*** |
| **Bushy Rock-cress** | ***Cardamine impatiens*** |
| **Canada bluegrass** | ***Poa compressa*** |
| **Chervil** | ***Anthriscus sylvestris*** |
| **Colts foot** | ***Tussilago farfara*** |
| **Common barberry** | ***Berberis vulgaris*** |
| **Common buckthorn** | ***Rhamnus cathartica*** |
| **Common / hedge privet** | ***Ligustrum vulgare*** |
| **Common mullein** | ***Verbascum thapsus*** |
| **Creeping buttercup** | ***Ranunculus repens*** |
| **Curly pondweed** | ***Potamogeton crispus*** |
| **Cypress spurge** | ***Euphorbia cyparissias*** |
| **Dame's rocket** | ***Hesperis matronalis*** |
| **Eurasian water-milfoil** | ***Myriophyllum spicatum*** |
| **Fanwort** | ***Cabomba caroliniana*** |
| **Garlic mustard** | ***Alliaria petiolata*** |
| **Giant waterweed** | ***Egeria densa*** |
| **Glossy buckthorn** | ***Rhamnus frangula*** |
| **Goutweed or Bishop's weed** | ***Aegopodium podagraria*** |
| **Hair fescue** | ***Festuca filiformis*** |
| **Hairy willow-herb** | ***Epilobium hirsutum*** |
| **Japanese barberry** | ***Berberis thunbergii*** |
| **Japanese honeysuckle** | ***Lonicera japonica*** |
| **Japanese hops** | ***Humulus japonicus*** |
| **Japanese knotweed** | ***Polygonum cuspidatum*** |
| **Japanese privet** | ***Ligustrum obtusifolium*** |
| **Japanese rose** | ***Rosa rugosa*** |
| **Kiwi vine** | ***Actinidia arguta*** |
| **Kudzu** | ***Pueraria montana*** |
| **Lesser naiad** | ***Najas minor*** |
| Live-forever or Orpine | *Sedum telephium* |
| Moneywort | *Lysimachia nummular* |
| **Morrow's honeysuckle** | ***Lonicera morrowii*** |
| **Morrow's X Tatarian honeysuckle (hybrid)** | ***Lonicera xbella*** |
| **Multiflora rose** | ***Rosa multiflora*** |
| **Norway maple** | ***Acer platanoides*** |
| **Oriental bittersweet** | ***Celastrus orbiculata*** |
| **Phragmites, Reed grass** | ***Phragmites australis*** |
| **Porcelain berry** | ***Ampelopsis brevipedunculata*** |
| Purple loosestrife | *Lythrum salicaria* |
| Reed canary-grass | *Phalaris arundinacea* |
| **Russian olive** | ***Elaeagnus angustifoli*** |
| Sea- or horned poppy | *Glaucium flavum* |
| Sheep fescue | *Festuca ovina* |
| Sheep-sorrel | *Rumex acetosella* |
| Silver lace-vine | *Polygonum aubertii* |
| Silver poplar | *Populus alba* |
| Spotted knapweed | *Centaurea biebersteinii* |
| Sweet reedgrass | *Glyceria maxima* |
| Sycamore maple | *Acer pseudoplatanus* |
| **Tatarian honeysuckle** | ***Lonicera tatarica*** |
| Tree-of-heaven | *Ailanthus altissima* |
| True forget-me-not | *Myosotis scorpioides* |
| Water-chestnut | *Trapa natans* |
| Watercress | *Rorippa nasturtium-aquaticum* |
| Western catalpa | *Catalpa speciosa* |
| White mulberry | *Morus alba* |
| Wild thyme | *Thymus pulegioides* |
| Winged euonymus | Euonymus alata |
| Variable water-milfoil | *Myriophyllum heterophyllum* |
| Yellow floating heart | *Nymphoides peltata* |
| Yellow iris | ***Iris pseudacorus*** |

# APPENDIX C

# SOIL PROFILE DESCRIPTION FORM

# APPENDIX C

## SOIL PROFILE DESCRIPTION FORM

**Location of Soil Profile**

| SOIL | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Depth** | **Horizon** | **Color (moist)** | | | **Texture** | **Structure** | **Roots** |
| | | **Matrix** | **Depletions** | **Concentrations** | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **Remarks:** | | | | | | | |